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REPORT FOR CONSULTATION ON THE METROPOLITAN LAS VEGAS INTERSTATE AIR QUALITY CONTROL REGION (NEVADA - ARIZONA)

National Air Pollution Control Administration
Washington, D. C.

June 1970

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ON THE
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NATIONAL TECHNICAL
INFORMATION SERVICE

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

REPORT FOR CONSULTATION

ON THE

METROPOLITAN LAS VEGAS

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(NEVADA-ARIZONA)

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
National Air Pollution Control Administration

June 1970

I a

SECTION I

THE REGIONAL APPROACH TO AIR QUALITY CONTROL AND A FEDERAL PROPOSAL FOR THE METROPOLITAN LAS VEGAS AREA.

I-1

PREFACE

The Clean Air Act, as amended, directs the Secretary of Health, Education, and Welfare to designate "air quality control regions" to provide a basis for the adoption of regional air quality standards and the implementation of those standards. The act stipulates that the designation of a region shall be preceded by consultation with appropriate State and local authorities. This report is intended to provide background material for the consultation. It proposes boundaries for the Metropolitan Las Vegas Interstate Air Quality Control Region and discusses the factors which are the basis of the boundary proposal.

The National Air Pollution Control Administration (NAPCA) has established a policy by which States may propose to the Federal Government boundaries for air quality control regions. Nevada is the fourth State to initiate proposals for region boundaries under this policy. The State of Nevada, Bureau of Environmental Health, and the Clark County District Health Department, with assistance from NAPCA, has conducted a study of the Las Vegas area, the results of which are presented in the body of this report. The Region boundaries proposed in the report reflect consideration of available and pertinent data; however, the boundaries remain subject to revision suggested by consultation between Federal, State, and local authorities. Formal designation of a Region will be made only after careful review of all

opinions and suggestions submitted during the consultation process. This report is intended to serve as the starting point for the consultation.

The Clean Air Act requires the designation of 'air quality control regions' prior to the adoptation of air quality standards and plans for implementation of the standards. A study was thus conducted of Las Vegas, Nevada.

The results of the study are presented in the report. It consists of a description of the region, an emission inventory, meteorology, and urban factors.

THE REGIONAL APPROACH

INTRODUCTION

Air pollution in the urban areas of the United States is a regional problem which frequently extends across governmental boundaries. Therefore, successful control of air pollution requires coordinated planning, standard setting, and enforcement by the several governmental jurisdictions which share a common problem. At the present time, State and local governments across the nation have only begun to develop a regional approach to air pollution control.

The Clean Air Act, as amended, provides a regional approach which depends upon coordination and cooperation between all levels of government; municipal, county, State, and Federa. To set in motion the machinery for regional air pollution control, the Department of Health, Education, and Welfare first designates air quality control regions, issues air quality criteria, and publishes reports on control techniques. The region designation indicates which State and local jurisdictions will be involved in a regional air pollution control effort. The air quality criteria indicate the extent to which various concentrations of an air pollutant are harmful to health and damaging to property. The reports on control techniques provide information on the costs and effectiveness of various techniques for controlling air pollutant emissions.

After the Department of Health, Education, and Welfare completes these initial steps, State governments develop air quality standards and plans for implementation of those standards for the air quality control region. An air quality standard defines the desired limit on the concentration of a pollutant in the ambient air of the region. It represents the degree of air quality which the regional control program will attempt to achieve. An implementation plan is a blueprint of the steps which will be taken to attain the chosen air quality standards within a reasonable time. The Governors have 90 days to submit letters indicating that they intend to set standards, 180 days in addition to set the standards, and 180 days further to develop plans for implementing them. The procedure for setting standards includes a public hearing which allows residents of a region to express their views concerning desired standards.

The Department of Health, Education, and Welfare reviews air quality standards and implementation plans in order to ascertain their consistency with the provisions of the Clean Air Act as amended.

When air quality standards and implementation plans are approved, States proceed to prevent and control air pollution in accordance with those standards and plans. This system for establishing a regional approach to air pollution control is depicted in the flow diagram in Figure 1.

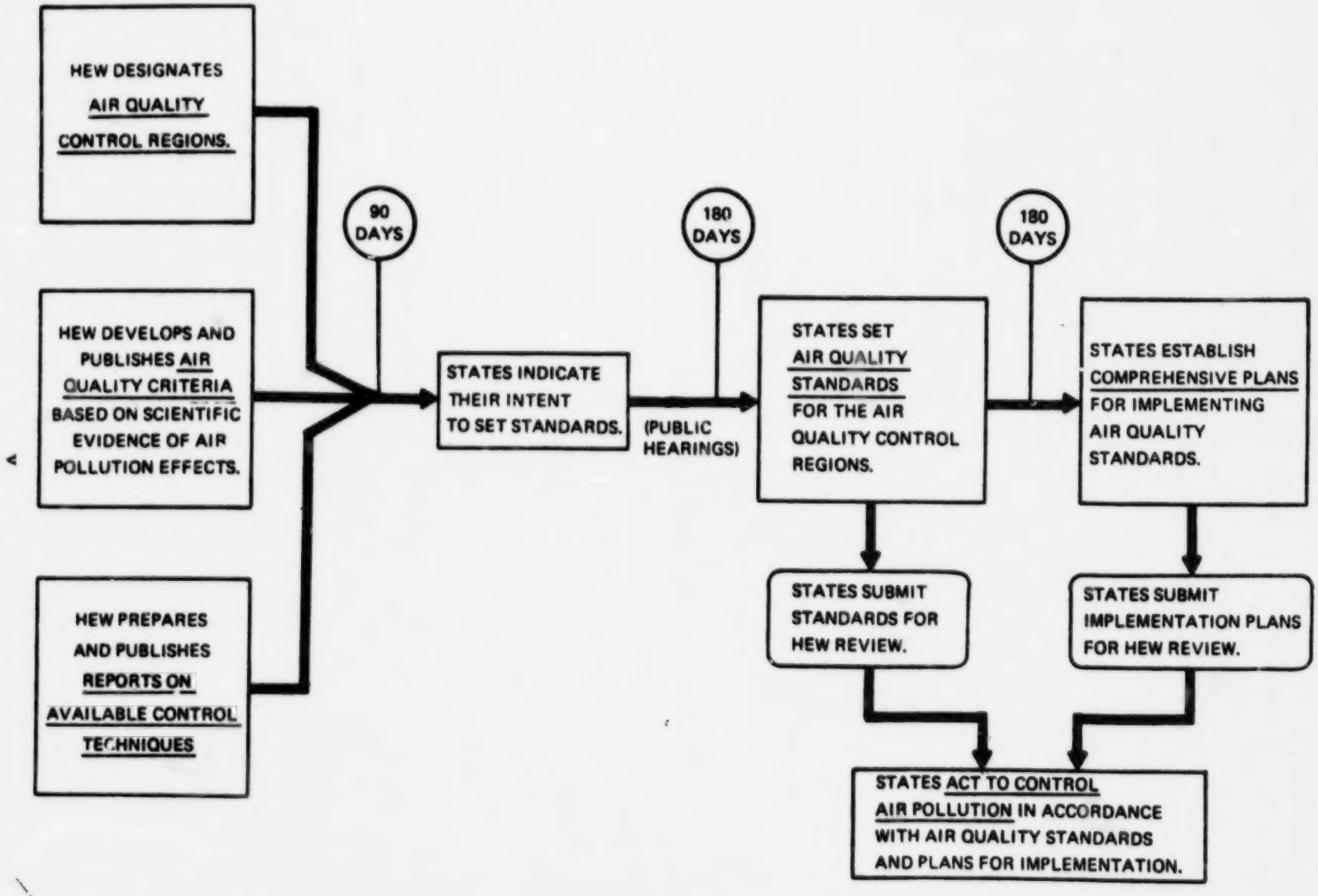

HEW DESIGNATES AIR QUALITY CONTROL REGIONS.
HEW DEVELOPS AND PUBLISHES AIR QUALITY CRITERIA BASED ON SCIENTIFIC EVIDENCE OF AIR POLLUTION EFFECTS.
HEW PREPARES AND PUBLISHES REPORTS ON AVAILABLE CONTROL TECHNIQUES
90 DAYS
STATES INDICATE THEIR INTENT TO SET STANDARDS.
180 DAYS
(PUBLIC HEARINGS)
STATES SET AIR QUALITY STANDARDS FOR THE AIR QUALITY CONTROL REGIONS.
180 DAYS
STATES ESTABLISH COMPREHENSIVE PLANS FOR IMPLEMENTING AIR QUALITY STANDARDS.
STATES SUBMIT STANDARDS FOR HEW REVIEW.
STATES SUBMIT IMPLEMENTATION PLANS FOR HEW REVIEW.
STATES ACT TO CONTROL AIR POLLUTION IN ACCORDANCE WITH AIR QUALITY STANDARDS AND PLANS FOR IMPLEMENTATION.

Figure 1 FLOW DIAGRAM FOR ACTION TO CONTROL AIR POLLUTION ON A REGIONAL BASIS, UNDER THE AIR QUALITY ACT.

DESIGNATION OF AIR QUALITY CONTROL REGIONS

Designation of an air quality control region is one of the first steps in the regional approach to air pollution control. Section 107(a)(2) of the Clean Air Act, as amended, directs the Secretary, Department of Health, Education, and Welfare to make such designations. The portions of the section relevant to this discussion state:

> "...The Secretary, after consultation with appropriate State and local authorities shall... designate air quality control regions based on jurisdictional boundaries, urban-industrial concentrations, and other factors including atmospheric areas necessary to provide adequate implementation of air quality standards. The Secretary may...revise the designation of such regions... The Secretary shall immediately notify the Governor or Governors of the affected State or States of such designation."

Procedure for Designation of Regions

Figure B illustrates the procedures used by the National Air Pollution Control Administration for designating air quality control regions whose boundaries are proposed by the State. States which wish to initiate a region designation may do so by preparing a report recommending boundaries for the region and justifying the recommendation in terms of engineering and urban factors. NAPCA will print the report prepared by the State along with a section prepared by NAPCA reviewing the State recommendation and offering NAPCA's own proposal for the region boundaries. NAPCA will distribute the combined report (such as this one) to interested State and local authorities. At the same time, NAPCA will set a time and place for a consultation meeting, at which Federal, State,

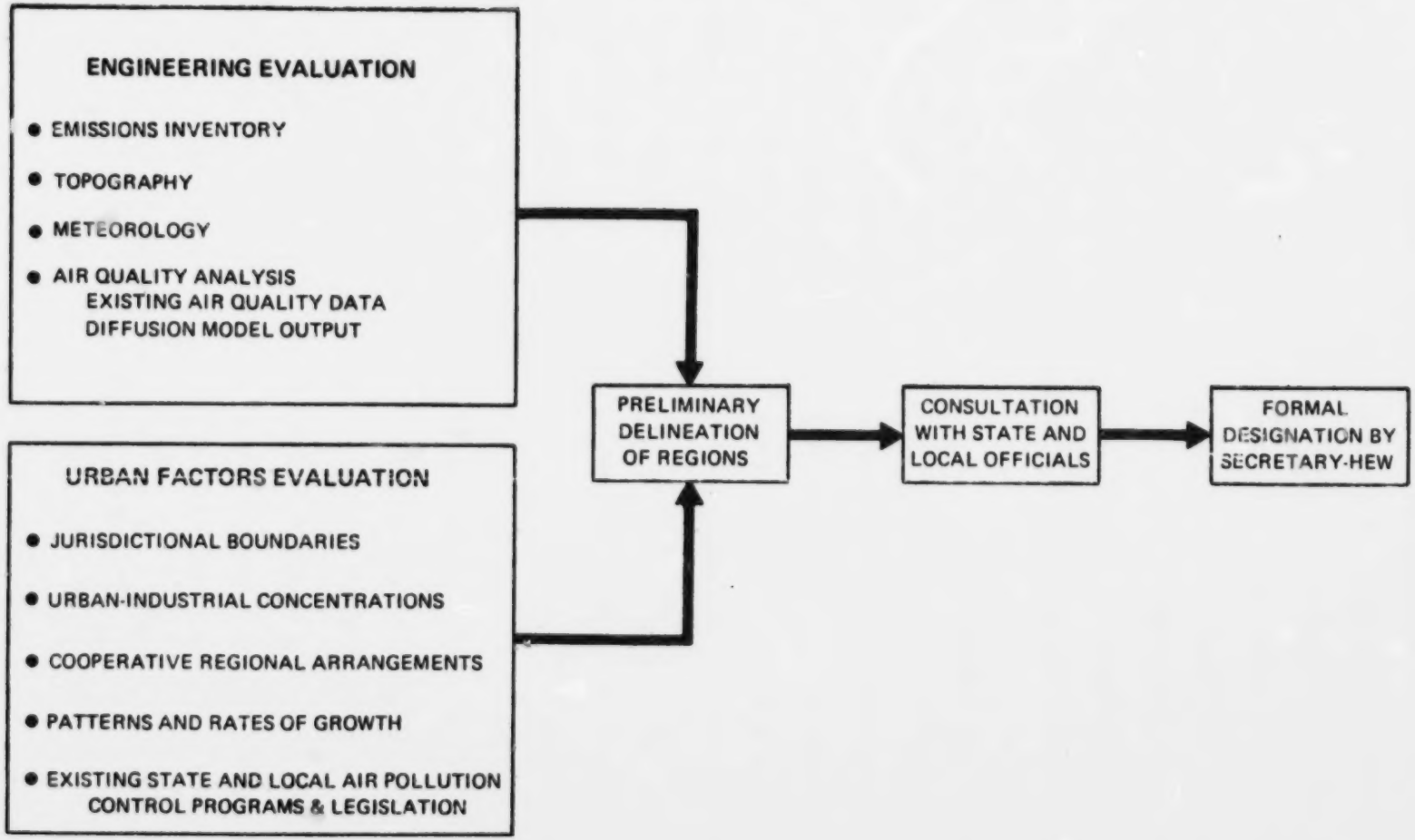

ENGINEERING EVALUATION
• EMISSIONS INVENTORY
• TOPOGRAPHY
• METEOROLOGY
• AIR QUALITY ANALYSIS
EXISTING AIR QUALITY DATA
DIFFUSION MODEL OUTPUT
URBAN FACTORS EVALUATION
• JURISDICTIONAL BOUNDARIES
• URBAN-INDUSTRIAL CONCENTRATIONS
• COOPERATIVE REGIONAL ARRANGEMENTS
• PATTERNS AND RATES OF GROWTH
• EXISTING STATE AND LOCAL AIR POLLUTION CONTROL PROGRAMS & LEGISLATION
PRELIMINARY DELINEATION OF REGIONS
CONSULTATION WITH STATE AND LOCAL OFFICIALS
FORMAL DESIGNATION BY SECRETARY-HEW

Figure 2. FLOW DIAGRAM FOR THE DESIGNATION OF AIR QUALITY CONTROL REGIONS.

and local representatives will be encouraged to present fully their views and suggestions concerning the State and Federal proposals. Interested parties who do not have official status may submit comments in written form for the record. After careful review of all suggestions and opinions submitted for the record, the Secretary of Health, Education, and Welfare formally designates the region, notifies the Governors affected by the designation, and announces the boundaries in the Federal Register.

The Size of a Region

As stipulated in Section 107(a)(2), the designation of air quality control regions should be based on "jurisdictional boundaries, urban-industrial concentrations, and other factors including atmospheric areas necessary to provide adequate implementation of air quality standards." This language suggests a number of objectives which are important in determining how large an air quality control region should be. Basically, these objectives can be divided into three separate categories.

First, a region should be self-contained with respect to air pollution sources and receptors. In other words, a region should include most of the important sources in the area as well as most of the people and property affected by those sources. In this way, all the major elements of the regional problem will lie within one unified administrative jurisdiction. Unfortunately, since air pollutants can travel long distances, it is impractical if not impossible to delineate regions which are completely self-contained.

The air over a region will usually have at least trace amounts of pollutants from external sources. During episodic conditions, such contributions from external sources may even reach significant levels. Conversely, air pollution generated within a region and transported out of it can affect external receptors to some degree. It would be impractical and inefficient to make all air quality control regions large enough to encompass these low-level trace effects. The geographic extent of trace effects overestimates the true problem area which should be the focus of air pollution control efforts. Thus, the first objective, that a region be self-contained, becomes a question of relative magnitude and frequency. The dividing line between "important influence" and "trace effect" will be a matter of judgment. The judgment should be based on estimates of the impact a source has upon a region, and the level of pollution to which receptors are subjected. In this respect, annual and seasonal data on pollutant emissions and ambient air concentrations are a better measure of relative influence than short-term data on episodic conditions.

The second general objective requires that region boundaries be designed to meet not only present conditions but also future conditions. In other words, the region should include areas where industrial and residential expansion are likely to create air pollution problems in the foreseeable future. This objective requires careful consideration of existing metropolitan development plans, expected population growth, and projected industrial expansion. Such considerations should result in the designation

of regions which will contain the sources and receptors of regional air pollution for a number of years to come. Of course, region boundaries need not be permanently fixed, once designated. Boundaries should be reviewed periodically and altered when changing conditions warrant readjustment.

The third objective is that region boundaries should be compatible with and even foster unified and cooperative governmental administration of the air resource throughout the region. Air pollution is a regional problem which often extends across several municipal, county, and even State boundaries. Clearly, the collaboration of several governmental jurisdictions is prerequisite to the solution of the problem. Therefore, the region should be delineated in a way which encourages regional cooperation among the various governmental bodies involved in air pollution control. In this regard, the existing pattern of governmental cooperation on the whole range of urban problems may become an important consideration. Certainly the pattern of cooperation among existing air pollution control programs is a relevant factor. In general, administrative considerations dictate that governmental jurisdictions should not be divided. Although it would be impractical to preserve State jurisdictions undivided, usually it is possible to preserve the unity of county governments by including or excluding them in their entirety. Occasionally, even this would be impractical due to a county's large size, wide variation in level of development, or striking topographical features.

To the extent that any two of the above three objectives lead to incompatible conclusions concerning region boundaries, the region must represent a reasonable compromise. A region should represent the best way of satisfying the three objectives simultaneously.

As noted above, the evaluation of relevant engineering factors and urban factors forms the basis of the boundary proposals. The evaluation of engineering factors is designed to indicate the location of pollution sources and the geographic extent of serious pollutant concentrations in the ambient air. Pollution sources are located by taking an inventory of emissions from automobiles, industrial activities, space heating, waste disposal, and other pollution generators. The transport and distribution of pollutants in the ambient air are analyzed on the basis of measured air quality data, the location of emissions, meteorological data, and topographic information. A mathematical diffusion model which predicts ambient pollution concentrations from information on emissions and meteorology can be used in areas where irregular topographical features would not invalidate the theoretical model. As a whole, the engineering study indicates how large the air quality control region must be in order to encompass most pollution sources and most people and property affected by those sources.

The study of urban factors encompasses non-engineering considerations. It reviews existing governmental jurisdictions, the location of urban and industrial considerations, expected

patterns of urban growth, cooperative regional arrangements, existing State and local air pollution control programs, and other associated factors. As a whole, the study of urban factors is designed to indicate how large a region must be in order to encompass expected regional growth and to encourage cooperation among political units in controlling air pollution.

The body of this report, compiled by the Vermont State Department of Health, contains a proposal for the boundaries of the Metropolitan Las Vegas Interstate Air Quality Control Region, and outlines the evaluation of engineering and urban factors which was the basis of the proposal.

THE FEDERAL PROPOSAL FOR THE METROPOLITAN LAS VEGAS INTERSTATE AIR QUALITY CONTROL REGION

Subject to the scheduled consultation, the Secretary, Department of Health, Education, and Welfare, proposes to designate an air quality control region for the Metropolitan Las Vegas area, consisting of the territory encompassed by the following jurisdictions:

In the State of Nevada:

Clark County

In the State of Arizona:

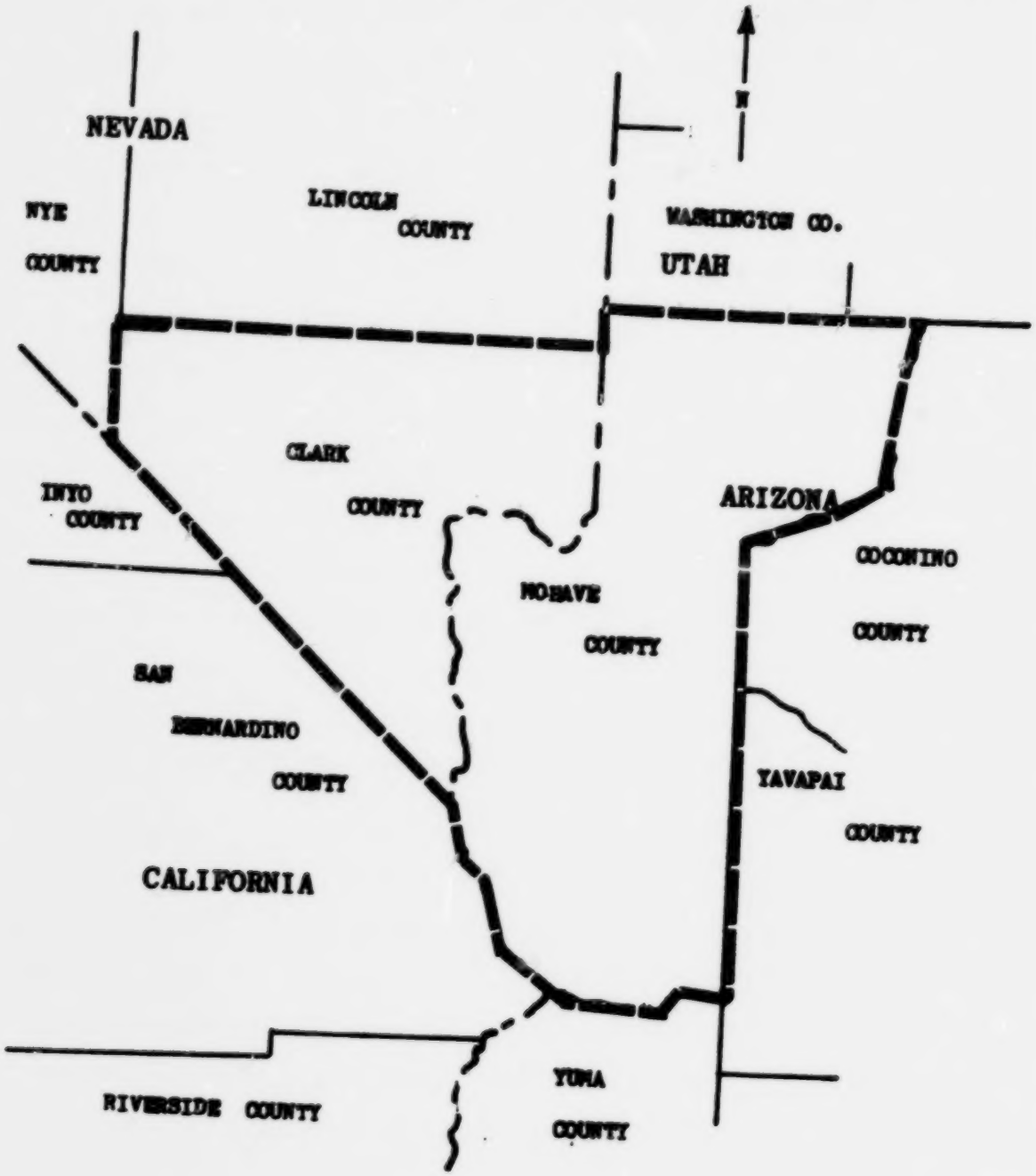
Mohave County

The proposed boundaries, illustrated in Figure 3, encompass the recommendation by the State of Nevada presented in Section II of this report, and includes Mohave County in the State of Arizona.

The National Air Pollution Control Administration has reviewed the proposal and supportive discussion prepared by the Clark County District Health Department and the State of Nevada. NAPCA concurs with the findings of their survey and therefore proposes Clark County as the Nevada portion of the interstate region. Furthermore, the National Air Pollution Control Administration believes that strong consideration should be given at the consultation to the possible inclusion of the Needles, California area into the region. The completion of the Mohave Power Plant will add to overall levels of pollution in the area and rapid population growth is expected to occur with the development of several recreation-oriented communities. The following discussion will outline the reasons for adding Mo ave County, Arizona to the proposed region.

First, the major topographical feature of the area is the Colorado River Valley which is split by the Clark County, Nevada - Mohave County, Arizona boundary. The river valley is about five miles wide at the intersection of the California-Nevada-Arizona borders. North of this point, the valley narrows to less than two miles with very steep slopes, rising to nearly 3,000 feet above the river. The narrowness of the valley, along with the location of the Mohave Power Plant on the Nevada side of the river directly across from the community of Bullhead City, Arizona, makes the inclusion of at least a portion of Mohave County essential to the region.

FIGURE 3. PROPOSED BOUNDARIES FOR THE METROPOLITAN LAS VEGAS INTERSTATE AIR QUALITY CONTROL REGION



Second, prevailing wind direction is from the southwest and west. Pollution from the Mohave Power Plant, as well as other sources in Clark County, are most likely to affect Mohave County. Fumigations are known to frequently occur north of Needles, California, and affect Mohave County as well as surrounding areas in California and Nevada.

Third, the largest single point source of emissions in the entire Study Area will be the Mohave Power Plant. This coal-fired steam generating plant will have a total of over 1.5 million KW capacity. Sulfur oxide emissions are estimated at 122.3 tons/day, or four times that of any other point source; nitrogen oxides are estimated at 128.8 tons/day, or over five times any other point source; and particulate emissions are third highest of any point source. Location of this major source adjacent to the Arizona boundary would recommend inclusion of Mohave County to adequately approach the region's air pollution problems.

Fourth, population and industrial growth is expected to occur at a rapid rate along the Colorado River Valley. Much of this growth is recreation-oriented, but at least one "New Town" is well underway - Lake Havasu City Mohave County, which grew from 5,572 persons in 1930 to 7,736 in 1960, is estimated to presently contain over 21,000 persons. This represents a 270% increase in only 10 years. It is interesting that this growth rate is over six times that of the State of Arizona, which was the second fastest growing state in the nation during the 1960's. Projected growth rates indicate Mohave County's population will reach 34,600 by 1975 and 46,000 by 1985. Growth within the

communities of Mohave County has also been significant. Kingman grew from 4,525 in 1960 to 6,021 in 1965, while the new community of Lake Havasu City has grown from a virtual wilderness to 4,000 persons during the past decade. Population growth such as Mohave County has witnessed is a strong indicator of the importance to protect and enhance the quality of its environment through the establishment of an air quality control region.

SECTION II

ANALYSIS AND PROPOSAL FOR THE NEVADA PORTION OF THE LAS VEGAS INTERSTATE AIR QUALITY CONTROL REGION

Prepared by the Clark County District Health Department in cooperation with the State of Nevada, Bureau of Environmental Health

June 1970

PREFACE

The Clark County District Health Department, in cooperation with the State of Nevada, Bureau of Environmental Health, developed the following report on the Nevada portion of the proposed Las Vegas Interstate Air Quality Control Region. The report format consists of three sections - Emission inventory, engineering factors, and urban factors. Part A, Emission Inventory, represents the results of a survey conducted by the National Air Pollution Control Administration using data obtained from officials in the Las Vegas area. Minor corrections have been made to NAPCA emission estimates by the Clark County District Health Department and are noted by an asterisk(*). The inventory provides estimates of the present levels of air pollutant emissions and the status of their control. The pollutants include sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides, and are delineated with respect to source type, season of year and geographical distribution within the area. The general procedure is based upon the rapid survey technique for estimating air pollutant emissions.[1] Part B, Engineering Factors, provides a background into the measured ambient air quality of the area and the theoretical concentrations throughout the region based upon a diffusion model. Also, a description of the topography and meterology of the area is provided. Part C, Urban Factors, describes the population, industrial composition, and jurisdictional aspects of the Nevada portion of the Las Vegas region.

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PART A

LAS VEGAS METROPOLITAN AREA

AIR POLLUTANT EMISSION INVENTORY

PART A. LAS VEGAS METROPOLITAN AREA AIR POLLUTANT EMISSION INVENTORY

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INTRODUCTION

This report is a summary of the Las Vegas air pollutant emission inventory conducted in March 1970. Since all inventories are based upon a calendar year, the data and emission estimates presented are representative of 1969 and should be considered as indicating the conditions as existed during that year.

The Study Area, which was chosen on the basis of the distribution of population and air pollution sources, consists of portions of four counties surrounding Las Vegas. This area covers approximately 19,400 square miles and had a 1969 population of 365,700.*

A grid coordinate system was used to show the geographical distribution of emissions within counties. The Study Area was subdivided into 76 grid zones ranging in size from 25 square kilometers in the heavily populated and industrialized areas to 1,600 square kilometers in the rural areas.

All sources of emissions were classified into five categories--transportation, stationary fuel combustion, solid-waste disposal, industrial processes and evaporative losses. Each of these source categories was divided into two subgroups--point sources and area sources. Facilities, which emit large quantities of air pollutants, were considered individually as point sources, while the many remaining contributors such as motor vehicles, residential and commercial fuel users, small industries and on-site refuse burning equipment, were considered collectively as area sources. For this report, thirty individual sources, which had emissions greater than 50 tons per year for any pollutant, were classified as point sources.

Emissions were estimated by using various indicators such as fuel consumption, refuse burning rates, vehicle-miles, production data, and control efficiencies and emission factors relating these indicators to emission rates.[2] These factors represent average emission rates for a particular source category. Since individual sources have inherent

differences that cannot always be taken into consideration, descrepancies between the actual and estimated emissions are more likely in individual sources than in the total emissions for a source category.

As in all emission surveys, the data presented are estimates and should not be interpreted as absolute values. The estimates are, in some cases, partial totals due to the lack of emission factors and production or consumption data. Despite these limitations, these estimates are of sufficient accuracy and validity in defining the extent and distribution of air pollutant emissions in the Study Area.

SUMMARY

The annual emissions as estimated by the Las Vegas Metropolitan Area Air Pollutant Emission Inventory are:

Sulfur Oxides	14,900	Tons/year
Particulates	63,500	Tons/year
Carbon Monoxide	209,100	Tons/year
Hydrocarbons	29,800	Tons/year
Nitrogen Oxides	22,800	Tons/year

The following is a brief description of the air pollutant emissions as presented in Table1 and Table 2.

Sulfur Oxides: The largest source of sulfur oxides in the Study Area was a coal burning power plant in Clark County. This plant accounted for over 80 percent of the total sulfur oxide emissions. The combustion of fuel oil at stationary sources was the second largest category contributing 11 percent of total emissions. The only other significant source was motor vehicles, which accounted for 6 percent of the total sulfur oxides.

Particulates: Individual point sources of particulates from industrial processes accounted for almost 75* percent of the total particulate emissions in the Las Vegas Study Area. Even though this area was void of any heavy industry, it did have a large number of plants in the mineral products industry. The largest sources in these industries were lime plants, gypsum plants, asphalt batching operations, ready-mix plants and miscellaneous sand and gravel operations. Collectively, these plants accounted for almost 76* percent of the 75* percent contributed by industrial process sources. The only other large source

of particulates was the coal burning power plant which accounted for 14* percent of total emissions.

Carbon Monoxide: In most metropolitan areas the largest source of carbon monoxide emissions is from automobiles and other motor vehicles. This was also true in Las Vegas as motor vehicles contributed 93 percent of the carbon monoxide emitted annually. Other transportation sources including railroad and aircraft operations contributed another 4 percent.

The only other significant source of carbon monoxide was from the inefficient cambustion of refuse at open burning dumps and incinerators. This category accounted for about 3 percent of the total emissions.

Hydrocarbons: Evaporative losses from automobiles which includes losses from the gas tank, carburetor and engine crankcase accounted for 27 percent of total hydrocarbon emissions. Other smaller evaporative loss sources--gasoline storage and handling, industrial solvent usage, dry cleaning plants and miscellaneous solvent usage collectively accounted for 14 percent of the total hydrocarbon emissions.

Exhaust gases from motor vehicles was a primary source of hydrocarbon emissions, accounting for over 47 percent of the total. Other sources included the open burning of solid waste and railroad and aircraft operations, which accounted for 2 and 9 percent, respectively, of total emissions.

Nitrogen Oxides: The major source of nitrogen oxides was the exhaust gas from motor vehicles, which together with other transportation sources contributed over 50 percent of the total nitrogen oxide emissions.

The combustion of coal and natural gas at the steam-electric plants in the Study Area was a large source of nitrogen oxides. In the Las Vegas area this source category accounted for 34 percent of the total emissions.

Other stationary fuel burning sources contributed 14%* while the remaining 2 percent of the total nitrogen oxides came from the disposal of refuse by incineration and open burning.

TABLE 1 SUMMARY OF AIR POLLUTANT EMISSIONS IN LAS VEGAS STUDY AREA, 1969 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	900	1,740	196,400	15,100	9,700
Other	60	1,570	7,100	2,500	1,600
Subtotal	960	3,310	203,500	17,600	11,300
Stationary Fuel Combustion					
Industry	200	130	10	10	1,100
Steam-Electric	12,000	8,900	160	60	7,700
Residential	400	100	20	30	350
Commercial and Institutional	1,100	400	50	50	1,900
Subtotal	13,700	9,530	240	150	11,050
Refuse Disposal					
Incineration	200	960	4,200	80	290
Open Burning	10	220	1,200	420	150
Subtotal	210	1,180	5,400	500	440
Industrial Processes	--	36,240	--	--	--
Evaporative Losses	--	--	--	11,500	--
GRAND TOTAL[a]	14,900	57,220	209,100	29,800	22,800

a Totals have been rounded.

TABLE 1A SUMMARY OF AIR POLLUTANT EMISSIONS IN LAS VEGAS STUDY AREA, 1969 (10^3 kg/year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	816	1,578	178,174	13,698	8,799
Other	54	1,424	6,441	2,268	1,451
Subtotal	870	3,002	184,615	15,966	10,250
Stationary Fuel Combustion					
Industry	181	118	9	9	328
Steam-Electric	10,886	8,074	145	54	6,985
Residential	363	91	18	27	317
Commercial and Institutional	997	363	45	45	1,724
Subtotal	12,427	8,646	217	135	10,024
Refuse Disposal					
Incineration	181	871	3,810	72	263
Open Burning	9	200	1,088	381	136
Subtotal	190	1,071	4,898	453	399
Industrial Process	--	32,873	--	--	--
Evaporative Losses	--	--	--	10,430	--
GRAND TOTAL[a]	13,500	52,248	189,700	27,000	20,700

a Totals have been rounded.

TABLE 2 PERCENTAGE CONTRIBUTION OF EACH SOURCE CATEGORY TO TOTAL EMISSIONS IN THE LAS VEGAS STUDY AREA

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	6.1	3.0	92.6	47.2	42.6
Other	0.4	2.6	4.1	9.0	7.0
Subtotal	6.5	5.6	96.7	56.2	49.6
Stationary Fuel Combustion					
Industry	1.2	1.2*	N	N	4.8
Steam-Electric	80.5	14.3*	0.1	0.2	33.9
Residential	2.8	1.2*	N	0.1	1.5
Commercial and Institutional	7.6	1.1*	N	0.2	8.2
Subtotal	92.1	17.8*	0.1	0.5	48.4
Refuse Disposal					
Incineration	1.3	1.6	2.5	0.3	1.3
Open Burning	0.1	0.4	0.7	1.5	0.7
Subtotal	1.4	2.0	3.2	1.8	2.0
Process Losses	--	74.6*	--	--	--
Evaporative Losses	--	--	--	41.5	--
TOTAL	100.0	100.0	100.0	100.0	100.0

GRID COORDINATE SYSTEM

A grid coordinate system, based on the Universal Transverse Mercator Projection (UTM) was used in the Las Vegas Study Area to show the geographical distribution of emissions. A map of this grid system is presented in Figure 4.

The UTM system was chosen due to its advantages over other standard grid systems such as the Latitude-Longitude and State Plane Coordinate Systems. The major advantages of this system are that (1) it is continuous across the country and is not hindered by political subdivisions, (2) the grids are of uniform size throughout the country, (3) it has world-wide use, and (4) the grids are square in shape--a necessary feature for use in meteorological dispersion models.

The Universal Transverse Mercator Projection is based upon the metric system. Each north-south and east-west grid line, as illustrated in Figure 4, is identified by a coordinate number expressed in meters. Each point source and grid is identified by the horizontal and vertical coordinates of their geographical center to the nearest 100 meters.

As shown in Figure 3,* the Study Area was divided into 76 grids of four different sizes--25, 100, 400 and 1,600 square kilometers. Grid zones of different sizes are used to limit the number of grid zones and yet allow a satisfactory definition of the geographical gradation of emissions. The majority of the emissions is usually concentrated in the populated and industrialized portions of a Study Area. Smaller grids are placed over these areas in order to reflect abrupt changes in emissions within short distances. The use of grid zones smaller than 25 square kilometers is not warranted because of the inherent inaccuracies in the data. Since only a small percentage of the total emissions occur in rural areas, larger grid zones are normally used to show the distribution of emissions in these lightly populated portions of a Study Area.

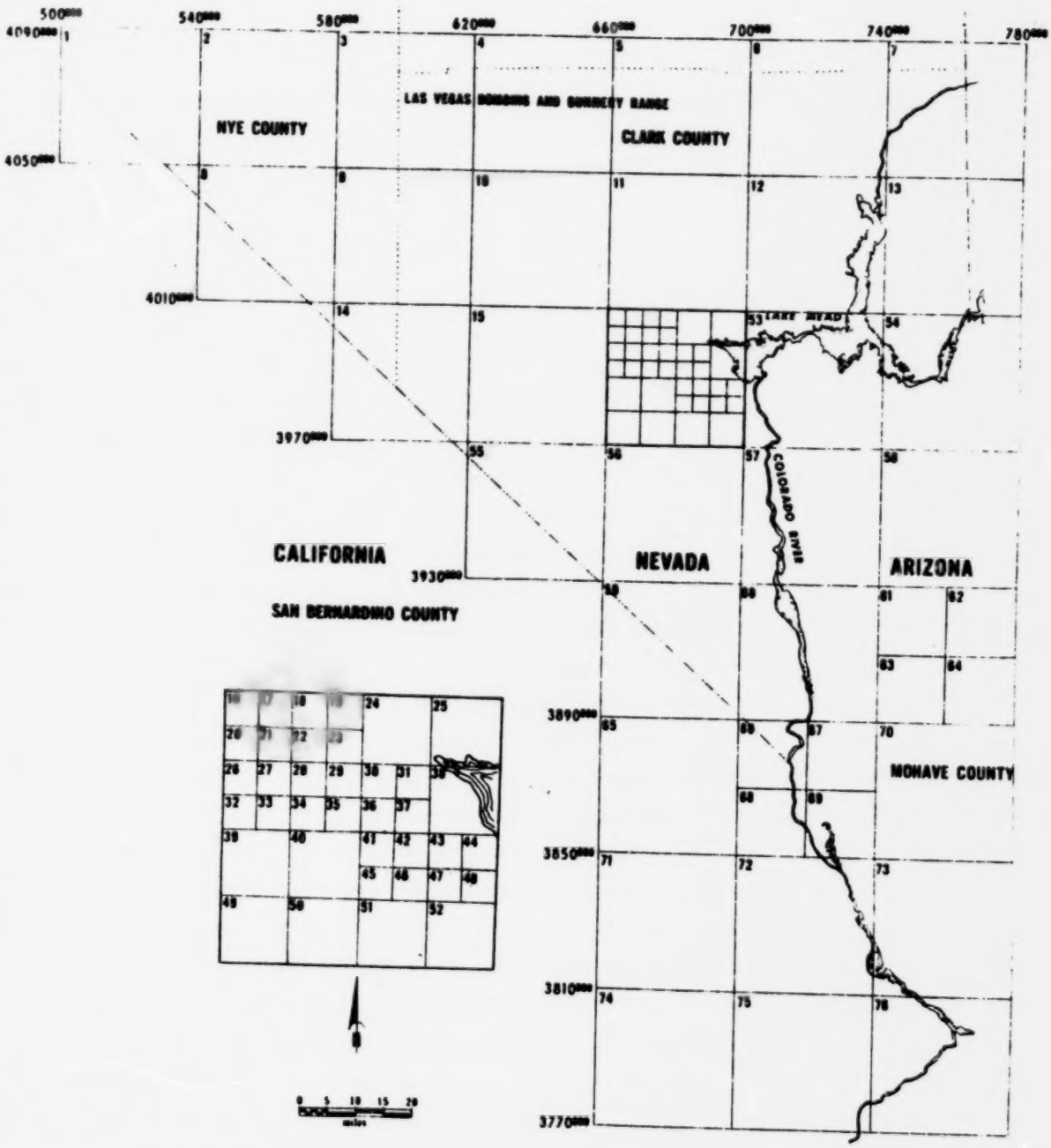

Figure 3A. Grid coordinate system for Las Vegas Study Area.

EMISSIONS BY CATEGORY

For the purposes of compiling the basic data and emission estimates, the air pollutant sources were classified into the following five categories:

1. Stationary fuel combustion
2. Transportation
3. Solid Waste disposal
4. Industrial processes
5. Evaporative losses

Each of these categories is considered individually in this section where data sources are given and methods of calculation discussed.

STATIONARY FUEL COMBUSTION

The stationary fuel combustion category is concerned with any fixed source which burns fuels for either space heating or process heating. The four primary sources in this category are industrial facilities, steam-electric plants, residential housing, and commercial and institutional establishments. In the Las Vegas area coal, natural gas, fuel oil, and liquified petroleum gas were the primary fuels used. Table 4 presents a summary of the fuels consumed in the Study Area.

Steam-Electric Utility

METHODOLOGY: Data on the four power plants in the area were acquired from each of the acknowledged air pollution agencies and compared to figures presented by the National Coal Association.[3] The data included the annual fuel consumption for 1968 and the method of firing employed at each plant.

RESULTS: Three of the four power plants in the area were gas fired and one was coal fired. These steam-electric generating plants consumed over 35 percent of the total natural gas utilized by all sources, and 100 percent of the coal. Air pollutant emissions from fuel combustion at

TABLE 3 ANNUAL FUEL CONSUMPTION IN THE POLITICAL SUBDIVISIONS OF THE LAS VEGAS STUDY AREA, 1969

Jurisdiction	Steam-Electric Utility	Industrial	Residential	Commercial and Institutional	Total
Natural Gas (Million Cu. Ft.)					
Clark	7,000	7,400	3,700	2,800	20,900
Mohave	1,200	200	300	180	1,880
Nye	--	--	--	--	--
San Bernadino	--	--	200	50	250
Total	8,200	7,600	4,200	3,030	23,030
Distillate Oil (1000 Gallons)					
Clark	--	7,900	16,600	45,900	70,400
Mohave	--	100	70	150	320
Nye	--	--	--	--	--
San Bernadino	--	--	--	--	--
Total	--	8,000	16,670	46,050	70,720
Residual Oil (1000 Gallons)					
Clark	--	50	--	1,200	1,250
Mohave	--	--	--	--	--
Nye	--	--	--	--	--
San Bernadino	--	--	--	--	--
Total	--	50	--	1,200	1,250
LPG (1000 Gallons)					
Clark	--	--	1,800	200	2,000
Mohave	--	--	--	--	--
Nye	--	--	20	--	20
San Bernadino	--	--	--	--	--
Total	--	--	1,820	200	2,020
Coal (Tons)					
Clark[a]	631,500	--	--	--	631,500
Total	631,500	--	--	--	631,500

these plants as well as from all other fuel combustion sources are summarized in Table 4. The steam-electric plants were significant sources of all pollutants. Over 87 percent of the total sulfur oxides from stationary fuel combustion, 85 percent of the particulates, 66 percent of the carbon monoxide, 40 percent of the hydrocarbons and 70 percent of the nitrogen oxides were attributed to these plants.

Industrial

METHODOLOGY: Natural gas numbers were obtained from each of the local suppliers who provided the breakdown by user category. Fuel oil consumption figures were provided by the air pollution agencies in each county. Specific data on the natural gas and fuel oil consumption by individual plants was obtained for the largest plants in the area, and these were considered as point sources. It was assumed that all remaining industrial fuel consumption was an area source and was apportionned onto grids based on industrial land use.

It should be noted that fuel combustion by industries includes both fuel used for space heating, and fuel used for process heating. A national average was used to separate process heating from space heating.

RESULTS: The emissions from the combustion of fuels by industrial sources were almost insignificant contributing less than 2 percent of the stationary fuel combustion emissions for any pollutant.

Residential

METHODOLOGY: Natural gas, distillate fuel oil, and LPG, for all practical purposes, were the only fuels used for residential home heating. There were homes heated by other fuels, but they represent a very small percentage of the total. Data on the amount of natural gas used for domestic heating was supplied by the local power companies and compared with the rapid survey technique of estimating the fuel used for residential heating.[4] LPG consumption data and distillate oil consumption were estimated by local officials and also compared to the rapid survey technique.

TABLE 4 AIR POLLUTANT EMISSIONS FROM THE COMBUSTION OF FUELS IN STATIONARY SOURCES IN THE STUDY AREA, 1969

(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Coal					
Industrial	--	--	--	--	--
Steam-Electric	12,000	8,840	160	60	6,300
Residential	--	--	--	--	--
Commercial and Institutional	--	--	--	--	--
Subtotal	12,000	8,840	160	60	6,300
Fuel Oil					
Industrial	180	60	10	10	290
Steam-Electric	--	--	--	--	--
Residential	410	70	20	30	100
Commercial and Institutional	1,140	360	50	50	1,700
Subtotal	1,730	490	80	90	2,090
Gas					
Industrial	N	70	N	N	810
Steam-Electric	N	50	N	N	1,370
Residential	N	40	N	N	240
Commercial and Institutional	N	30	N	N	160
Subtotal	N	190	N	N	2,580
GRAND TOTAL[a]	13,700	9,500	240	150	11,000

N = Negligible

a = Totals have been rounded

RESULTS: Residential sources accounted for 20 percent of the total hydrocarbons from stationary fuel combustion, and less than 3 percent of the emissions for all other pollutants.

Commercial and Institutional

METHODOLOGY: Commercial and institutional establishments use primarily natural gas and distillate fuel oil. Data on the amount of natural gas used by these establishments were provided by the local power company.

RESULTS: Commercial and institutional sources accounted for 8 percent of the total sulfur oxides from stationary fuel combustion, 8 percent of the particulates, 40 percent of the hydrocarbons, 17 percent of the nitrogen oxides and less than 1 percent of the carbon monoxide.

TRANSPORTATION

Three types of transportation sources of air pollution are considered in this survey--motor vehicles, aircraft, and railroads. Motor vehicles, which are by far the most significant source in this category, are further subdivided according to type of fuel--gasoline or diesel.

Motor Vehicles

Almost 6* million vehicle miles/day were traveled by motor vehicles in 1969 in the Las Vegas Study Area. In the process, 148* million gallons of gasoline and 11* million gallons of diesel fuel were consumed for highway purposes. Table 5 shows the miles of travel for gasoline and diesel vehicles for each county in the Study Area.

Vehicle-mile data for essentially all of the roads in Clark County were supplied by the Clark County District Health Department which had conducted an extensive survey for 1969. For Clark County, this data was in the form of traffic flow maps which showed vehicle mile data on a traffic zone basis. This data was then transferred onto the UTM grid zones and reported as total vehicle miles for each grid. In the remaining counties, vehicle-mile information was not available, and thus gasoline consumption was used to find vehicular emissions.[5]

TABLE 5. VEHICLE MILES OF TRAVEL FOR MOTOR VEHICLES IN THE LAS VEGAS STUDY AREA, 1969 (Thousand Vehicle Miles per Day)

Political Jurisdiction	Diesel Vehicle Miles	Gasoline Vehicle Miles	Total
Clark	251*	5,286*	5,537*
Mohave	14	266	280
Nye	6	109	115
San Bernadino	11	209	220
TOTAL	272*	5,870*	6,142*

The contribution to the total motor vehicle pollution by diesel-powered vehicles was determined by assuming that approximately five percent of the total vehicle miles traveled were by diesel-powered vehicles. This was checked by estimating diesel fuel consumption in each county.[6] These emissions were apportionned on a grid basis by assuming they were proportional to gasoline emissions.

Emissions from motor vehicles are a function of the speed at which the vehicle travels. Average speeds of 10-20 mph wer assumed for downtown areas, 20-30 mph for the residential areas, and 30-45 mph for the rural areas to calculate vehicle emissions.

From all transportation sources, motor vehicles accounted for 94* percent of the sulfur oxides, 53* percent of the particulates, 96* percent of the carbon monoxide, 86* percent of the hydrocarbons, and 86* percent of the nitrogen oxides. Gasoline powered motor vehicles contributed a greater percent of all pollutants than diesel powered motor vehicles. Emissions from transportation sources are summarized in Table 6.

Aircraft

Table 7 shows the air traffic activity at the largest airports in the Study Area. An estimate of the number of flights by engine type was supplied by the traffic controller at each airport.

The air pollutant emissions from aircraft include all phases of operation (taxi, take-off, climb out, approach and landing) that take place below the arbitrarily chosen altitude of 3,500 feet. Emissions at cruise altitude (above 3,500 feet) are not of concern in an emission inventory. From all transportation sources, aircraft accounted for 40 percent of the particulates, 4 percent of the carbon monoxide, 14 percent of the hydrocarbons and 11 percent of the nitrogen oxides.

Railroads

Railroad operations (mainly locomotive) consume about 3 million gallons of diesel fuel per year within the Study Area. This quantity is about 80 percent less than the amount of diesel fuel consumed by motor vehicles. The majority of this fuel is consumed during switching operations. Diesel fuel consumption data were supplied by each of the major railroads in the Las Vegas area.

TABLE 6 SUMMARY OF EMISSIONS FROM TRANSPORTATION SOURCES, 1969
(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxide
Motor Vehicles					
Gasoline	540	720	195,800	13,850	7,650
Diesel	370	1,020	560	1,260	2,060
Subtotal	910	1,740	196,360	15,110	9,710
Aircraft					
Jet	N	1,340	1,480	1,250	980
Piston	N	20	5,460	1,020	260
Turboprop	N	40	90	30	60
Subtotal	N	1,400	7,030	2,300	1,300
Railroads	60	170	90	210	340
GRAND TOTAL[a]	970	3,300	203,500	17,600	11,300

N = Negligible

a = Totals have been rounded

TABLE 7 AIR TRAFFIC ACTIVITY AT THE LARGEST AIRPORTS IN THE LAS VEGAS STUDY AREA, 1969 (Flights/Year)[a]

Type Aircraft	McCarran	Nellis AFB	North Las Vegas
2 Engine Conventional Jet	42,000	9,200	5,700
3 Engine Conventional Jet	--	19,600	--
4 Engine Conventional Jet	--	20,000	--
3 Engine Fan Jet	58,000	--	--
4 Engine Fan Jet	28,000	--	--
1 Engine Turboprop	3,400	10,000	3,600
2 Engine Turboprop	7,300	22,000	7,300
4 Engine Turboprop	3,700	5,800	--
1 Engine Piston	15,000	--	10,300
2 Engine Piston	12,100	1,100	7,700
4 Engine Piston	--	5,200	--
TOTAL	169,500	92,900	34,600

a - Flight is defined as a combination of a landing and a take-off.

Railroad operations contribute about 5 percent of the particulates and 14 percent of the hydrocarbons from all transportation sources. They account for less than 3 percent of the emissions for any other pollutant.

SOLID WASTE DISPOSAL

Approximately 767,000 tons of refuse was generated during 1969 within the Study Area. Table 8 presents a solid waste balance for the Las Vegas Study Area, showing the various methods of disposal and the quantities disposed of by each method. The bulk of the refuse in Clark County was disposed of by landfills or non-burning dumps, whereas in all other counties it was burned in open burning dumps. Refuse data for all of the counties were supplied by the air pollution agencies in each county.

INDUSTRIAL PROCESSES

The Study Area is notably void of any heavy industrial complexes with the exception of the one in Henderson, Nevada. From an air pollution standpoint, the mineral products industry was by far the most significant industrial process source. The largest sources in this industry were three lime manufacturing plants, two gypsum plants, seven asphalt batching operations, two cinderblock plants, five ready-mix plants and three miscellaneous sand and gravel operations plants. Other industries that generate air pollutant emissions from their processes include 1 manganese plant and 1 titanium metals plant. Table 10 presents a summary of the emissions from the various industrial processes.

The three lime plants were the largest particulate sources from industrial processes. Approximately 1.8 million tons of dolomite limestone were mined and processed in 1969. Operations at these plants which release contaminants include mining, crushing and pulverizing, screening, calcinating and hydrating. All of the kilns at these plants are equipped with multicyclone mechanical dust collectors.

TABLE 8 SOLID WASTE BALANCE FOR LAS VEGAS STUDY AREA, 1969

Jurisdiction	Total Refuse Generated	On-site Incineration	Landfills Non-Burning Dumps	Open Burning Dumps	Open Burning On-site
Clark	735,000	188,400	546,600	--	--
Mohave	22,000	2,200	--	20,000	NA
Nye	3,000	300	1,000	1,700	NA
San Bernadino	7,000	700	--	6,300	NA
TOTAL	767,000	191,600	547,700	28,000	--

NA = Information not available or not reported

TABLE 9 AIR POLLUTANT EMISSIONS FROM SOLID-WASTE DISPOSAL IN LAS VEGAS STUDY AREA, 1969 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Incineration					
Municipal	--	--	--	--	--
On-Site	190	960	4,200	80	290
Subtotal	190	960	4,200	80	290
Open Burning					
On-Site	NA	NA	NA	NA	NA
Dump	10	220	1,200	420	150
Subtotal	10	220	1,200	420	150
GRAND TOTAL	200	1,180	5,400	500	440

TABLE 10 PARTICULATE MATTER EMISSIONS FROM INDUSTRIAL PROCESSES, 1969
(Tons/Year)

Source Category	Particulates
Chemical Process Industry	
Manganese	40
Metallurgical Industry	
Titanium	600
Mineral Products Industry	
Lime	14,500*
Gypsum	7,900*
Asphalt	6,600
Cinder Block	Neg.
Ready Mix	3,800
Sand and Gravel Operations	2,800
Subtotal	48,900
GRAND TOTAL	36,240*

These plants accounted for almost 40* percent of the total particulates from industrial processes.

Approximately 700,000 tons of gypsum are mined at the two sites in the Study Area. The pulverizing, crushing, screening and stockpiling operations that take place at these plants contribute 32*percent of the total process particulates.

At the seven asphalt plants the actual batching operation along with sand and gravel mining accounted for 18*percent of the total process particulates. Mining operations associated with ready mix production and other sand and gravel operations collectively account for 18* percent of the total particulate emissions from industrial processes.

The only other significant industrial process source of particulates was the one titanium plant.

EVAPORATIVE LOSSES

Three source categories were considered for evaporative losses--automobiles, gasoline storage and handling, and the consumption of solvents. The hydorcarbon emissions from all sources by evaporative losses are shown in Table 12.

Automobiles

Automobile evaporation losses include gas tank and carburetor evaporation and engine crankcase blowby. Since 1963, most new automobiles were equipped with positive crankcase ventilation (PCV) valves that reduce hydrocarbon emissions from the crankcase by about 90 percent. Due to a lag time in the automobile replacement rate, it was assumed that 20 percent of the automobiles were not equipped with PCV valves.

The hydrocarbon emissions from automobiles were calculated from vehicle-mile data and were apportioned onto grids using the same methods as for motor vehicles discussed earlier. Evaporative losses from automobiles accounted for 66 percent of the total hydrocarbon emissions from evaporative losses in the Study Area.

Gasoline Storage and Handling

There are four major points (excluding evaporation from the motor vehicle) of hydrocarbon emissions in the storage and handling of gasoline. They are:

1. Breathing and filling losses from storage tanks
2. Filling losses from loading tank conveyances
3. Filling losses from loading underground storage tanks at service stations
4. Spillage and filling losses in filling automobile gas tanks at service stations.

Approximately 148* million gallons of gasoline and diesel fuel were consumed in the Study Area in 1969. The evaporative losses from the storage and the subsequent handling of the gasoline accounted for 19 percent of the total evaporative losses.

Consumption of Solvents

This category included the consumption of solvents at dry cleaning plants, industrial solvent usage and the miscellaneous use of solvents by small commercial establishments and domestic units. Organic solvents emitted from these operations were determined by assuming an emission rate of 4 lb/capita/year for dry cleaning plants, and 3 lb/capita/year for miscellaneous consumption.[7, 8] The industrial solvent consumption was based on actual numbers provided by the local agencies. The consumption of solvents by these three categories accounted for 15 percent of the hydrocarbon emissions from evaporative losses.

TABLE 11 HYDROCARBON EMISSIONS FROM EVAPORATIVE LOSSES, 1969
(Tons/Year)

Source Category	Hydrocarbon Emissions
Automobiles	7,600
Gasoline Storage and Handling	2,000
Consumption of Solvents	
Dry Cleaning Plants	760
Industry	690
Miscellaneous	470
Subtotal	1,920
GRAND TOTAL	11,520

EMISSIONS BY JURISDICTION

The previous section presented the air pollutant emissions by source category. In order to show the contribution of each county to the pollution in the entire Study Area, their emissions are summarized in Tables 12 through 15.

As is expected due to a higher degree of urbanization than the other counties, Clark County accounts for 99 percent of the total sulfur oxides in the Study Area, 93 percent of the particulates, 91 percent of the carbon monoxide, 90 percent of the hydrocarbons, and 92 percent of the nitrogen oxides.

TABLE 12 SUMMARY OF AIR POLLUTANT EMISSIONS IN CLARK COUNTY, 1969
(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	800	1,540	180,700	13,800	8,600
Other	20	1,460	7,060	2,380	1,420
Subtotal	820	3,000	187,760	16,180	10,020
Stationary Fuel Combustion					
Industry	180	120	10	10	970
Steam-Electric	12,000	8,900	160	60	7,700
Residential	410	100	20	30	320
Commercial and Institutional	1,140	380	50	50	1,860
Subtotal	13,730	9,500	240	150	10,850
Refuse Disposal					
Incineration	190	940	4,140	80	280
Open Burning	--	--	--	--	--
Subtotal	190	940	4,140	80	280
Industrial Processes	--	33,140	--	--	--
Evaporative Losses	--	--	--	10,220	--
GRAND TOTAL[a]	14,700	46,600	192,100	26,600	21,200

N = Negligible

a = Totals have been rounded

TABLE 13 SUMMARY OF AIR POLLUTANT EMISSIONS IN MOHAVE COUNTY, 1969
(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	50	90	8,900	720	520
Other	40	110	60	140	220
Subtotal	90	200	8,960	860	740
Stationary Fuel Combustion					
Industry	N	10	N	N	130
Steam-Electric	N	N	N	N	N
Residential	N	N	N	N	20
Commercial and Institutional	N	10	N	N	160
Refuse Disposal					
Incineration	N	10	50	N	N
Open Burning	10	160	850	300	110
Subtotal	10	170	900	300	110
Industrial Processes	N	3,060	N	N	N
Evaporative Losses	--	--	--	660	--
GRAND TOTAL[a]	100	3,400	9,900	1,800	1,600

N = Negligible

a = Totals have been rounded.

TABLE 14 SUMMARY OF AIR POLLUTANT EMISSIONS IN NYE COUNTY, 1969

(Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	20	40	2,660	240	210
Other	--	--	--	--	--
Subtotal	20	40	2,660	240	210
Stationary Fuel Combustion					
Industry	N	N	N	N	N
Steam-Electric	N	N	N	N	N
Residential	N	N	N	N	N
Commercial and Institutional	N	N	N	N	N
Subtotal	N	N	N	N	N
Refuse Disposal					
Incineration	N	N	10	N	--
Open Burning	N	10	70	30	10
Subtotal	N	10	80	30	10
Industrial Processes	--	--	--	--	--
Evaporative Losses	--	--	--	210	--
GRAND TOTAL[a]	20	50	2,700	500	200

N = Negligible

a = Totals have been rounded

TABLE 15 SUMMARY OF AIR POLLUTANT EMISSIONS IN SAN BERNADINO COUNTY 1969, (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	30	70	4,130	380	380
Other	N	N	N	10	10
Subtotal	30	70	4,130	390	390
Stationary Fuel Combustion					
Industry	N	N	N	N	N
Steam-Electric	N	N	N	N	N
Residential	N	N	N	N	10
Commercial and Institutional	N	N	N	N	N
Subtotal	N	N	N	N	10
Refuse Disposal					
Incineration	N	N	10	N	N
Open Burning	N	50	270	90	30
Subtotal	N	50	280	90	30
Industrial Process	--	--	--	--	--
Evaporative Losses	--	--	--	390	--
GRAND TOTAL[a]	30	120	4,400	900	400

N = Negligible

a = Totals have been rounded.

EMISSIONS BY GRID

For the purpose of defining the geographical variation of air pollutant emissions in the Study Area, the resulting emissions were apportioned on the grid coordinate system. The emissions were divided into two source groups--point and area sources. Thirty point sources are identified individually with respect to location and emissions. Each of these point sources emitted more than 50 tons per year of any pollutant.

CONTRIBUTIONS OF POINT AND AREA SOURCES

Figure 4 shows the location of all point sources in the area. Collectively the thirty point sources account for 80 percent of the sulfur oxides, 94 percent of particulate matter, 43 percent of nitrogen oxides, 4 percent of the carbon monoxide and 8 percent of the hydrocarbons. The percentage contribution to carbon monoxide emissions is low because motor vehilces, which are area sources, contribute 93 percent of the total carbon monoxide emissions. Similarly, the contribution to total hydrocarbon emissions is low since two groups of area sources, motor vehicles and evaporative losses are the major sources. Table 16 presents the emissions of point sources. Each source is identified by source category, grid number and horizontal and vertical coordinates. The emissions of sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides are shown for an average annual day, average winter day (December, January, February), and average summer day (June, July, August). The appendix presents the method of calculating these three averages.

Area sources are sources of emissions that are insignificant by themselves, but as a group may emit a large portion of the areas total pollution. Examples of area sources are motor vehicles, residences, light commercial and industrial establishments and backyard burning. The emissions from area sources have been added to that for point sources to obtain total emissions from all sources by grid, as shown in Table 17. The emissions from all sources are also shown for an annual average, winter and summer day.

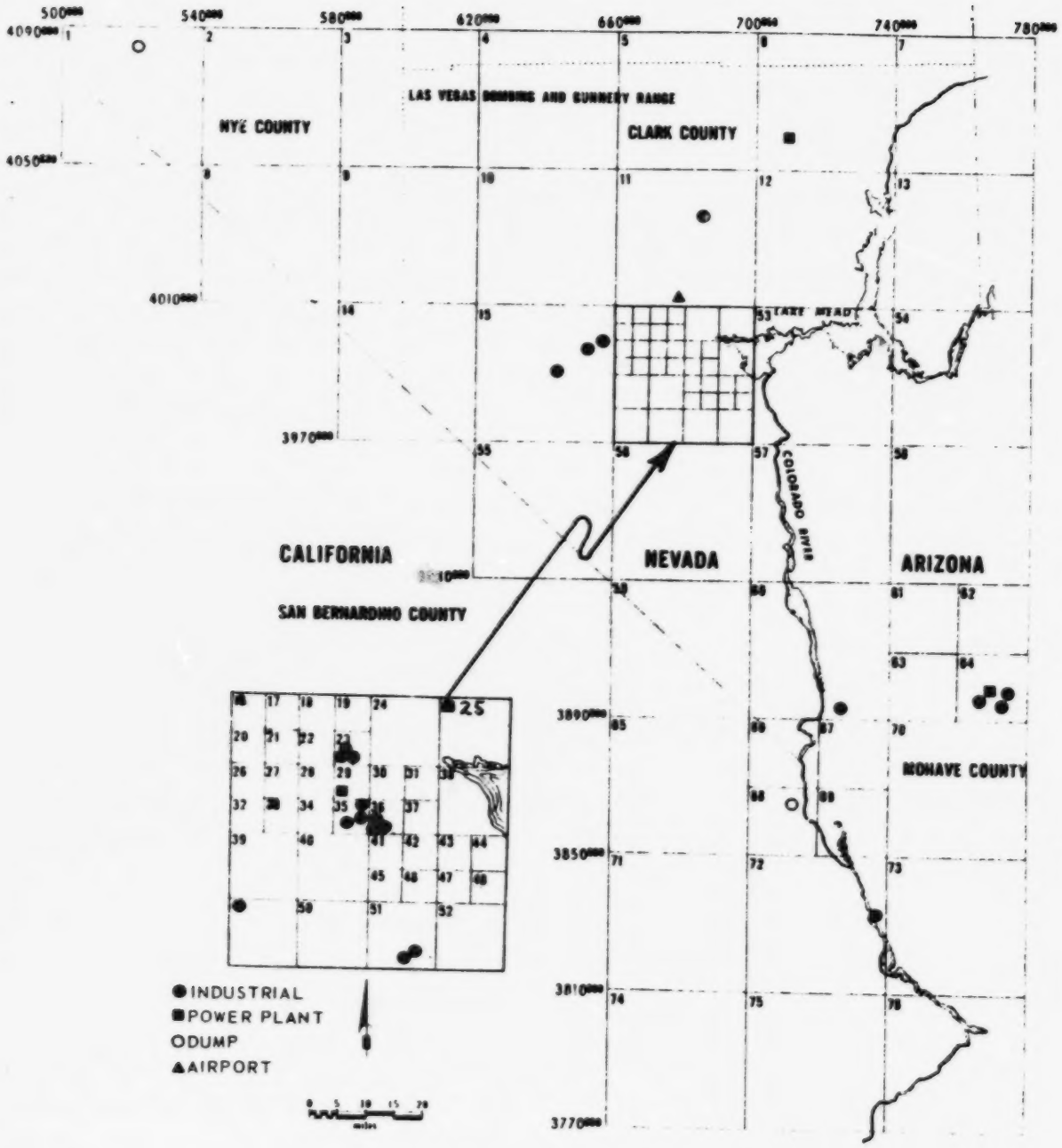

Figure 4 Location of point sources in Las Vegas Study Area.

TABLE 16 SUMMARY OF AIR POLLUTANT EMISSIONS FROM POINT SOURCES IN THE LAS VEGAS STUDY AREA
TONS/DAY

ID	GRIDHC	VC	SOX S	SOX W	SOX A	PART S	PART W	PART A	CO S	CO W	CO A	HC S	HC W	HC A	NOX S	NOX W	NOX A
5	1 5200	40850	0.0	0.0	0.0	0.02	0.02	0.02	0.15	0.13	0.13	0.04	0.04	0.04	0.01	0.01	0.01
4	6 7110	40595	46.6	33.3	32.8	34.38	24.55	24.22	0.61	0.43	0.43	0.24	0.17	0.17	24.55	17.54	17.30
2	11 6850	40360	0.0	0.0	0.0	31.99	31.99	31.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	11 6765	40118	0.0	0.0	0.0	1.91	1.91	1.91	6.47	6.47	6.47	1.35	1.35	1.35	1.45	1.45	1.45
2	15 6457	39914	0.0	0.0	0.0	10.89	10.89	10.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	15 6577	39992	0.0	0.0	0.0	13.59	13.59	13.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	15 6588	39993	0.0	0.0	0.0	3.76	3.76	3.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	16 6620	40090	0.0	0.0	0.0	0.16	0.16	0.16	4.02	4.02	4.02	0.77	0.77	0.77	0.28	0.28	0.28
2	23 6768	40031	0.0	0.0	0.0	0.66	0.66	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	23 6779	400 9	0.0	0.0	0.0	0.73	0.73	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	23 6769	400 9	0.0	0.0	0.0	0.12	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	3.15	2.25	2.22
2	25 6910	40090	0.0	0.0	0.0	6.50	6.51	6.51	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.34	0.25
4	29 6758	39952	0.0	0.0	0.0	0.08	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	2.17	1.55	1.52
7	33 6670	39940	0.0	0.0	0.0	1.75	1.75	1.75	8.76	8.76	8.76	4.19	4.19	4.19	1.83	1.83	1.83
2	35 6773	39919	0.0	0.0	0.0	1.16	1.16	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	35 6787	39922	0.0	0.0	0.0	1.20	1.20	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	35 6787	39942	0.0	0.0	0.0	4.00	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	36 6810	399 1	0.0	0.0	0.0	0.19	0.21	0.20	0.00	0.00	0.00	0.00	0.00	0.00	1.30	1.30	1.11
2	36 6820	399 1	0.0	0.0	0.0	1.67	1.68	1.68	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.58	0.50
2	36 6801	399 4	0.0	0.0	0.0	14.49	14.49	14.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	49 6610	39796	0.0	0.0	0.0	33.89	33.89	33.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	51 6864	39725	0.0	0.0	0.0	1.80	1.80	1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	51 6863	39724	0.0	0.0	0.0	0.69	0.69	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	60 7220	38930	0.0	0.0	0.0	0.41	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	64 7705	38977	0.0	0.0	0.0	0.64	0.64	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	64 7670	38979	0.0	0.0	0.0	1.36	1.36	1.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	64 7720	38995	0.0	0.0	0.0	5.79	5.79	5.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	64 7685	38973	0.0	0.0	0.0	0.00	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.35
4	68 7140	39060	0.0	0.0	0.0	0.12	0.12	0.12	0.64	0.64	0.64	0.22	0.22	0.22	0.08	0.08	0.08
2	72 7390	39910	0.0	0.0	0.0	0.16	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ID KEY

5 = Dump
4 = Steam-Electric Utility
2 = Industrial
7 = Airport

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TABLE 17 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES IN LAS VEGAS STUDY AREA, 1968
TONS/ DAY

	(Sq. Mi.)	SOX			PART			CO			HC			NOX		
GRID	AREA	S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
1	617.7	0.0	0.0	0.0	0.1	0.1	0.1	3.2	2.5	2.9	0.6	0.5	0.5	0.3	0.2	0.3
2	617.7	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.4	1.6	0.3	0.2	0.3	0.2	0.1	0.1
3	617.7	0.0	0.0	0.0	0.0	0.0	0.0	2.1	1.6	1.9	0.3	0.3	0.3	0.2	0.1	0.1
4	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
6	617.7	46.7	33.5	32.9	34.4	24.6	24.3	2.5	1.9	2.1	0.6	0.4	0.5	24.7	17.8	17.5
7	617.7	0.0	0.0	0.0	0.1	0.1	0.1	3.9	3.0	3.5	0.6	0.5	0.5	0.2	0.2	0.2
8	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0
9	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.6	0.7	0.2	0.2	0.2	0.1	0.1	0.1
10	617.7	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.3	1.6	0.2	0.2	0.2	0.1	0.1	0.1
11	617.7	0.0	0.2	0.1	34.0	34.1	34.0	12.9	11.5	12.3	2.3	2.1	2.2	1.9	2.1	1.9
12	617.7	0.0	0.1	0.0	0.0	0.0	0.0	2.4	1.9	2.2	0.3	0.3	0.3	0.2	0.2	0.2
13	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
14	617.7	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.8	0.9	0.2	0.1	0.2	0.1	0.1	0.1
15	617.7	0.1	0.1	0.1	28.4	28.3	28.4	7.7	6.0	7.0	1.0	0.8	0.9	0.5	0.4	0.5
16	9.6	0.2	0.5	0.3	0.8	0.8	0.8	32.6	26.4	30.1	5.3	4.6	5.0	1.9	1.8	1.8
17	9.6	0.3	0.5	0.4	0.5	0.5	0.5	56.6	43.8	51.5	6.2	4.9	5.7	2.6	2.4	2.5
18	9.6	0.4	0.4	0.4	0.7	0.6	0.7	68.0	52.6	61.9	8.5	6.6	7.7	3.7	2.9	3.4
19	9.6	0.0	0.0	0.0	0.0	0.0	0.0	3.2	2.4	2.9	0.4	0.3	0.3	0.2	0.1	0.2
20	9.6	0.2	0.5	0.3	0.6	0.6	0.6	41.7	32.5	38.0	5.4	4.4	5.0	1.9	1.7	1.8
21	9.6	1.0	7.6	3.4	2.0	4.0	2.8	147.4	115.2	134.5	17.3	14.6	16.2	5.4	14.4	8.7
22	9.6	0.1	0.2	0.1	0.3	0.2	0.3	22.0	17.0	20.0	2.9	2.3	2.6	1.2	1.0	1.1
23	9.6	0.0	0.0	0.0	1.5	1.5	1.5	0.3	0.2	0.2	0.0	0.0	0.0	3.2	2.3	2.2
24	38.6	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.1	2.5	0.4	0.3	0.3	0.2	0.1	0.2
25	38.6	0.0	0.0	0.0	6.5	6.5	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.3

TABLE 17 (cont.)

GRID	(Sq. Mi.) AREA	SOx S	SOx W	SOx A	S	W	A	CO S	CO W	CO A	HC S	HC W	HC A	NOx S	NOx W	NOx A
26	9.6	0.2	0.5	0.3	0.5	0.5	0.5	40.8	31.6	37.1	5.1	4.0	4.7	2.2	2.2	2.2
27	9.6	0.1	0.1	0.1	0.2	0.2	0.2	11.8	9.2	10.7	1.6	1.3	1.5	0.6	0.5	0.6
28	9.6	0.1	0.1	0.1	0.2	0.2	0.2	13.5	10.5	12.3	1.8	1.5	1.7	0.7	0.6	0.7
29	9.6	0.0	0.0	0.0	0.1	0.1	0.1	2.3	1.8	2.1	0.3	0.2	0.3	2.3	1.6	1.6
30	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	9.6	0.1	0.4	0.2	0.2	0.3	0.2	11.0	8.6	10.0	1.6	1.3	1.5	0.7	1.1	0.8
33	9.6	0.1	0.4	0.2	1.9	2.0	1.9	16.6	14.9	15.9	5.3	5.1	5.3	2.3	2.7	2.4
34	9.6	0.0	0.0	0.0	0.0	0.0	0.0	3.8	2.9	3.4	0.5	0.4	0.4	0.2	0.2	0.2
35	9.6	0.0	0.1	0.0	6.5	6.5	6.5	2.1	1.7	2.0	0.4	0.4	0.4	0.1	0.1	0.1
36	9.6	0.0	0.0	0.0	16.4	16.4	16.4	0.3	0.2	0.3	0.0	0.0	0.0	1.5	1.9	1.6
37	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0
38	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	38.6	0.3	0.2	0.2	0.5	0.4	0.5	42.9	33.2	39.0	5.7	4.4	5.2	2.8	2.1	2.5
40	38.6	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.2	1.4	0.2	0.2	0.2	0.1	0.1	0.1
41	9.6	0.1	1.7	0.7	0.3	0.8	0.5	3.5	3.1	3.3	1.3	1.3	1.3	0.3	2.7	1.2
42	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0
47	9.6	0.0	0.2	0.1	0.0	0.1	0.1	0.3	0.2	0.3	0.1	0.2	0.2	0.0	0.4	0.2
48	9.6	0.0	0.1	0.1	0.1	0.1	0.1	1.7	1.4	1.6	0.4	0.3	0.3	0.1	0.2	0.1
49	38.6	0.1	0.1	0.1	34.0	34.0	34.0	11.0	8.5	10.0	1.5	1.1	1.3	0.7	0.5	0.6
50	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	38.6	0.0	0.0	0.0	2.5	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	617.7	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.0	1.2	0.2	0.2	0.2	0.1	0.1	0.1
54	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.4	0.1	0.1	0.1	0.0	0.0	0.0

TABLE 17 (cont.)

GRID	(Sq. Mi.) AREA	SOx S	SOx W	SOx A	PART. S	PART. W	PART. A	CO S	CO W	CO A	HC S	HC W	HC A	NOx S	NOx W	NOx A
55	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0
56	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.3	0.1	0.0	0.1	0.0	0.0	0.0
57	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.4	0.1	0.1	0.1	0.0	0.0	0.0
58	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.0
59	617.7	0.0	0.0	0.0	0.0	0.0	0.0	3.1	2.4	2.8	0.4	0.3	0.4	0.2	0.2	0.2
60	617.7	0.0	0.0	0.0	0.5	0.5	0.5	2.3	1.8	2.1	0.4	0.3	0.4	0.2	0.1	0.2
61	154.4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.6	0.7	0.1	0.1	0.1	0.1	0.1	0.1
62	154.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.0
63	154.4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.6	0.7	0.1	0.1	0.1	0.1	0.0	0.1
64	154.4	0.2	0.2	0.2	0.5	0.5	0.5	22.3	17.7	20.9	1.7	1.1	1.5	1.6	1.4	1.9
65	617.7	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.2	1.4	0.3	0.2	0.3	0.2	0.1	0.2
66	154.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
67	154.4	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.0
68	154.4	0.1	0.0	0.0	0.2	0.2	0.2	5.4	4.7	5.4	1.3	1.1	1.2	0.5	0.5	0.5
69	154.4	0.0	0.0	0.0	0.1	0.1	0.1	0.7	0.6	0.6	0.2	0.2	0.2	0.2	0.2	0.2
70	617.7	0.0	0.0	0.0	0.1	0.1	0.1	0.7	0.6	0.6	0.2	0.2	0.2	0.2	0.2	0.2
71	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72	617.7	0.0	0.0	0.0	0.2	0.2	0.2	2.9	2.3	2.6	0.5	0.4	0.5	0.3	0.2	0.3
73	617.7	0.0	0.0	0.0	0.1	0.1	0.1	0.4	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1
74	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	617.7	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.1	2.5	0.5	0.4	0.4	0.3	0.2	0.2
76	617.7	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.4	0.5	0.1	0.1	0.1	0.1	0.0	0.0

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EMISSION DENSITIES

In order to provide a visual representation of the emissions of pollutants by grids, emission density maps have been prepared. Emission densities were obtained by summing the annual area and point source emissions for each grid and dividing this total by the land area of the grid. Figures 5 through 9 show the variation in emission densities for the respective grids throughout the Study Area. As expected the emissions generally follow the pattern and degree of urbanization. Emission densities for carbon monoxide and hydrocarbons are higher in the grids with the higher populations and corresponding higher vehicular activity. Particulate emissions are high only in areas where industries are located and in grid 6 where the coal burning power plant is located. Sulfur oxide emission densities are relatively low in the Las Vegas area. The only grid with a high density was grid 6. This was due to the power plant located in this grid.

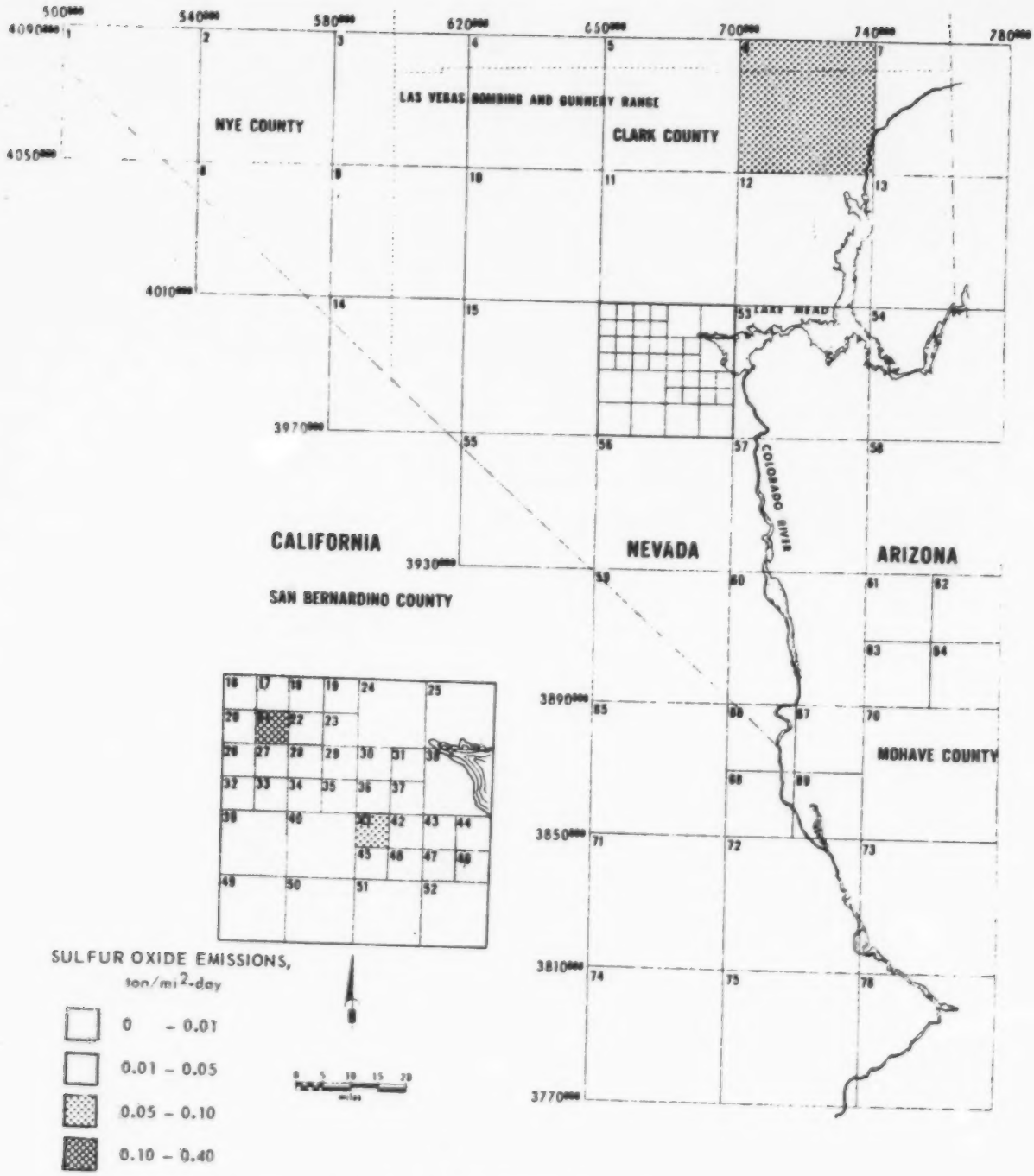


Figure 5. Sulfur oxide emission density from all sources in Las Vegas Study Area.

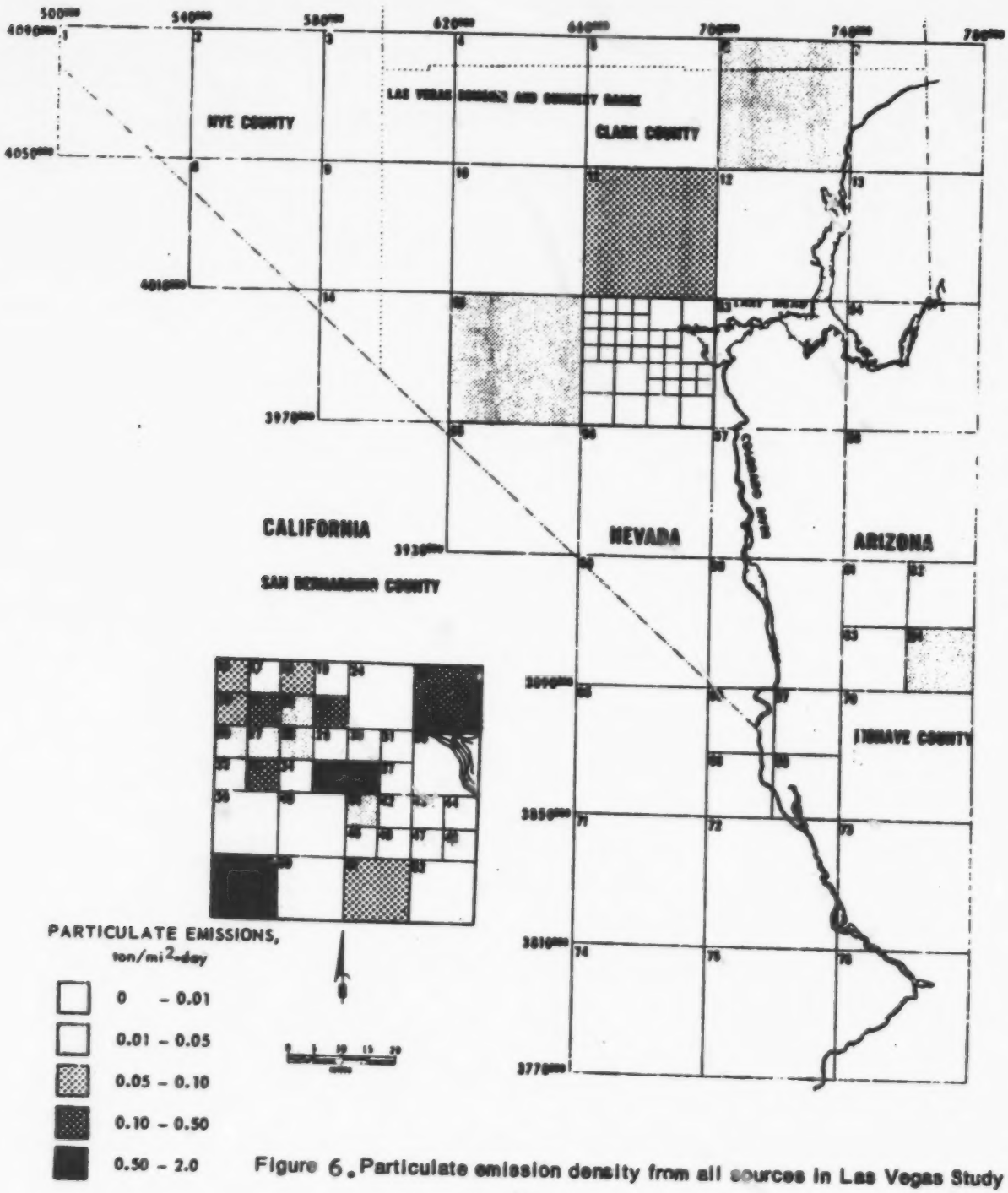


Figure 6. Particulate emission density from all sources in Las Vegas Study Area.

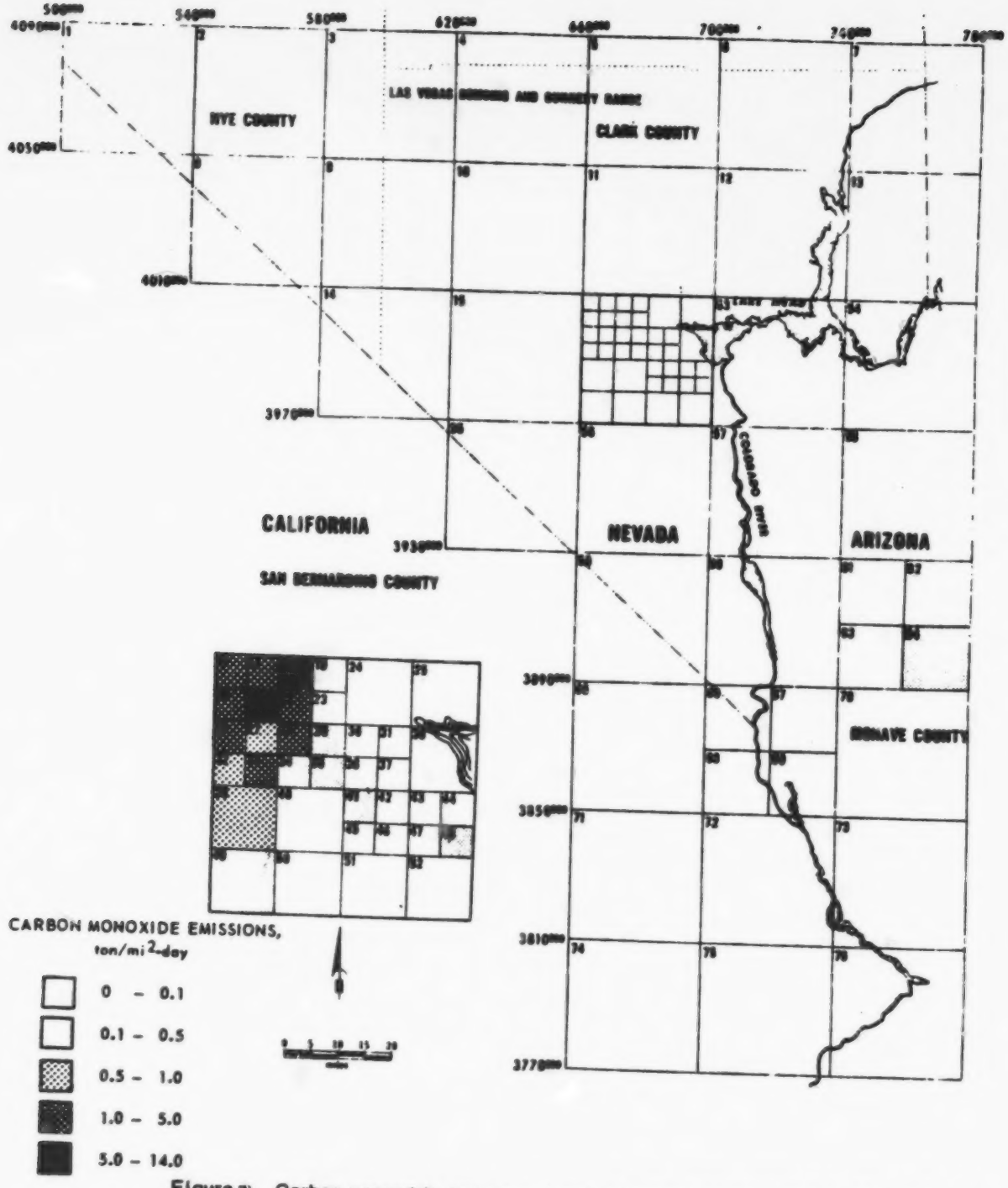


Figure 7. Carbon monoxide emission density from all sources in Las Vegas Study Area.

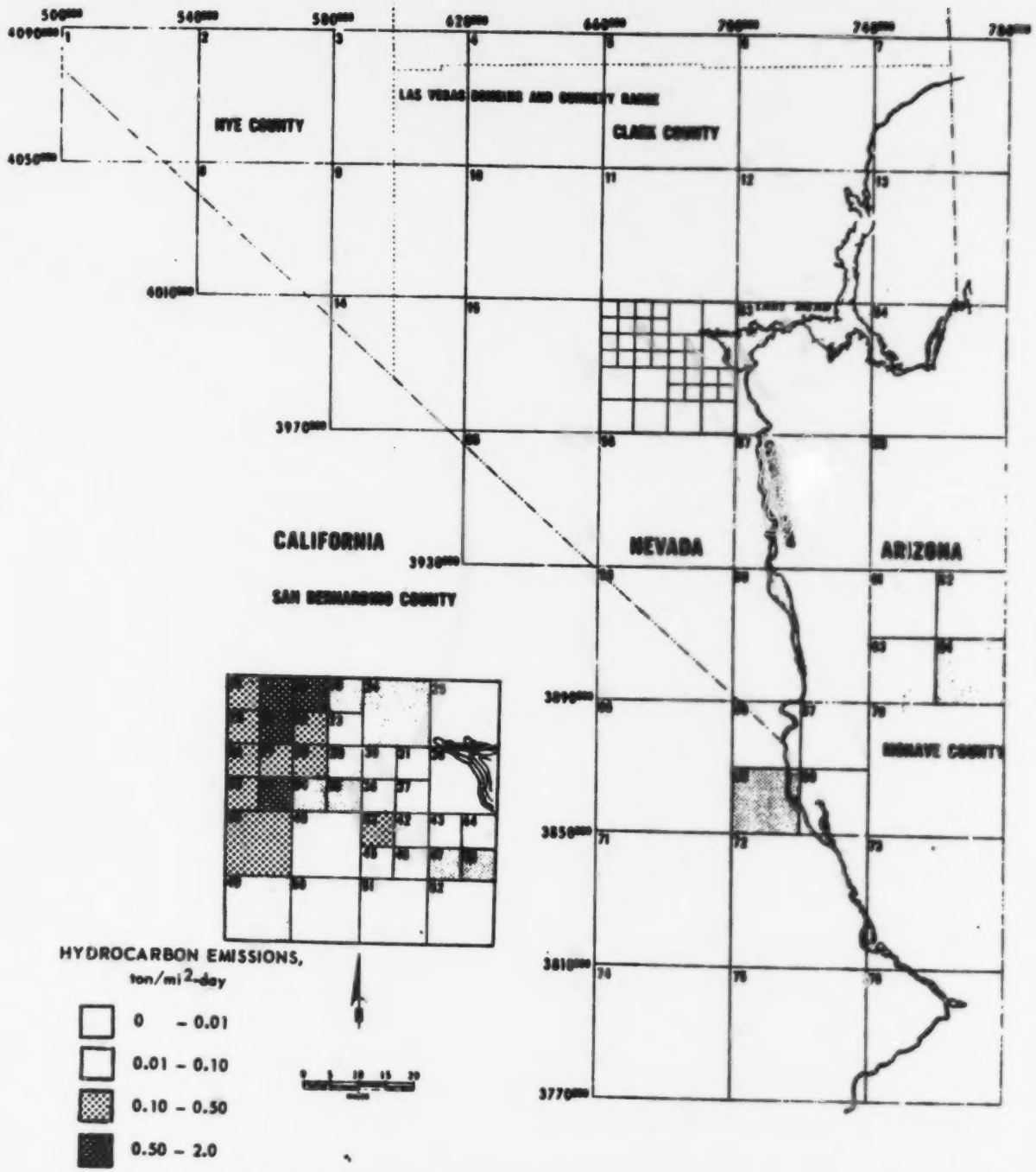


Figure 8. Hydrocarbon emission density from all sources in Las Vegas Study Area.

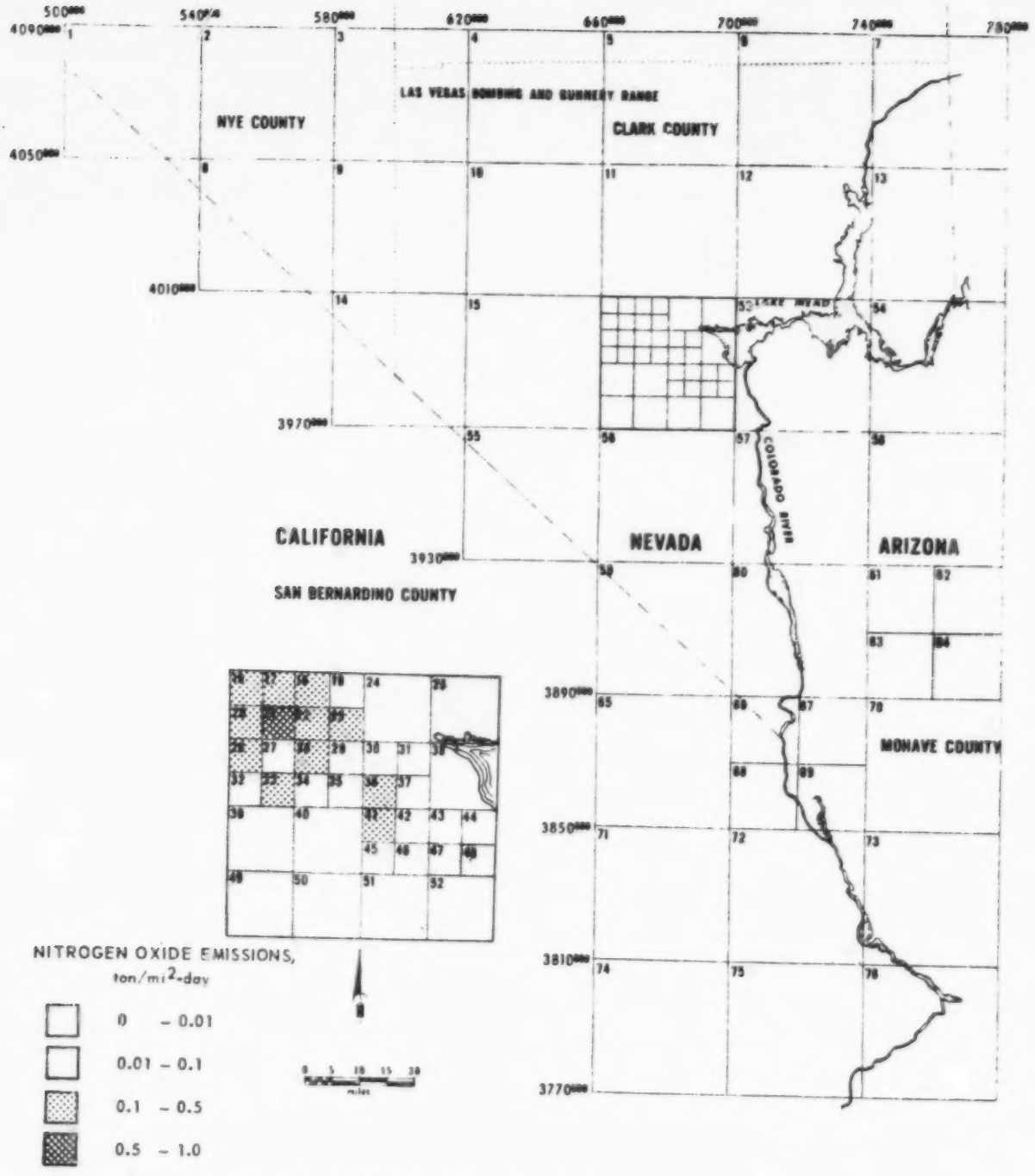


Figure 9. Nitrogen oxide emission density from all sources in Las Vegas Study Area.

YEARLY AVERAGE (A)

$$A = \frac{\text{Fuel Consumed} \times \text{Emission Factor (E. F.)}}{\text{Days of Operation}}$$

e.g. A plant consumed 100,000 tons of coal in 1967 while operating 365 days. The total degree days for the area was 4,800 and 2,800 for the three winter months. The plant was estimated to use 15 percent of the fuel for space heating and 85 percent for process heating. From this information, the annual average emission for carbon monoxide would be the following:

$$A = \frac{100{,}000 \text{ Tons/year} \times 3 \text{ lbs. CO/Ton coal}}{365 \text{ Days/year} \times 2{,}000 \text{ lb./Ton}}$$

$$A = 0.41 \text{ Ton/Day}$$

WINTER AVERAGE (W)

$$W = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Winter Operation}} \times \frac{\text{Winter Degree Days}}{\text{Total Degree Days}} \times \text{\% Fuel Used for space heating}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \text{\% Fuel used for process heating}$$

$$W = \left[\frac{100{,}000 \times 2{,}800}{90 \times 4{,}800} \times 0.15 + \frac{100{,}000}{365} \times 0.85\right] \frac{3}{2{,}000}$$

$$W = 0.49 \text{ Ton/Day}$$

SUMMER AVERAGE (S)

$$S = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Summer Operation}} \times \frac{\text{Summer Degree Days}}{\text{Total Degree Days}} \times \text{\% Fuel Used for space heating}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \text{\% Fuel used for process heating}$$

$$S = \left[\frac{100{,}000}{90} \times \frac{0}{4{,}800} \times 0.15 + \frac{100{,}000}{365} \times 0.85\right] \frac{3}{2{,}000}$$

$$S = 0.35 \text{ Ton/Day}$$

APPENDIX B
METRIC CONVERSION FACTORS

Multiply	By	To Obtain
Feet	0.3048	Meters
Miles	1609	Meters
Square Feet	0.0929	Square meters
Square Miles	2.59	Square kilometers
Pounds	453.6	Grams
Pounds	$453.6/10^4$	Tons (metric)
Tons (metric)	1.103	Tons (short)
Tons (short)	907.2	Kilograms
Tons (short)	.9072	Tons (metric)

To Obtain	By	Divide

PART B

EVALUATION OF

ENGINEERING FACTORS

METEOROLOGY

The sun shines in the study area 86 percent of the time. The climate of the study area is classified as dry, subtropical and rain is rare. Total precipitation is about 3.74 inches per year, contributing to an average humidity level of only 22%. During the summer months, daily temperatures in excess of 100°F are common, but average temperature is 82°F. Spring and fall temperatures average about 70°F. Winter temperatures have been recorded as low as 18°F but generally average about 52°F. The wind is predominately out of the Southwest summer and winter. The wind averages about 13 miles per hour in the winter and 10 miles per hour in the summer. Summer, winter, and annual wind roses are shown in figures 10, 11 and 12.

TOPOGRAPHY [9]

The study area is located in and around the southern tip of Nevada. Las Vegas is situated near the center of a broad desert valley almost completely surrounded by mountains ranging from 2,000 to 10,000 feet higher than the valley floor. To the North, the valley isbounded by the Sheep Range, the Spring Mountain range to the West, the Mc Cullough range to the South, and the River Mountains and Sun Rise Mountains to the East. Thus Vegas Valley, comprising about 600 square miles, runs from Northeast to Southeast, and slopes gradually upward on each side toward the mountains. To the Southeast of Las Vegas is Lake Mead which was produced by the impounded waters of the Colorado behind Hoover Dam. A series of

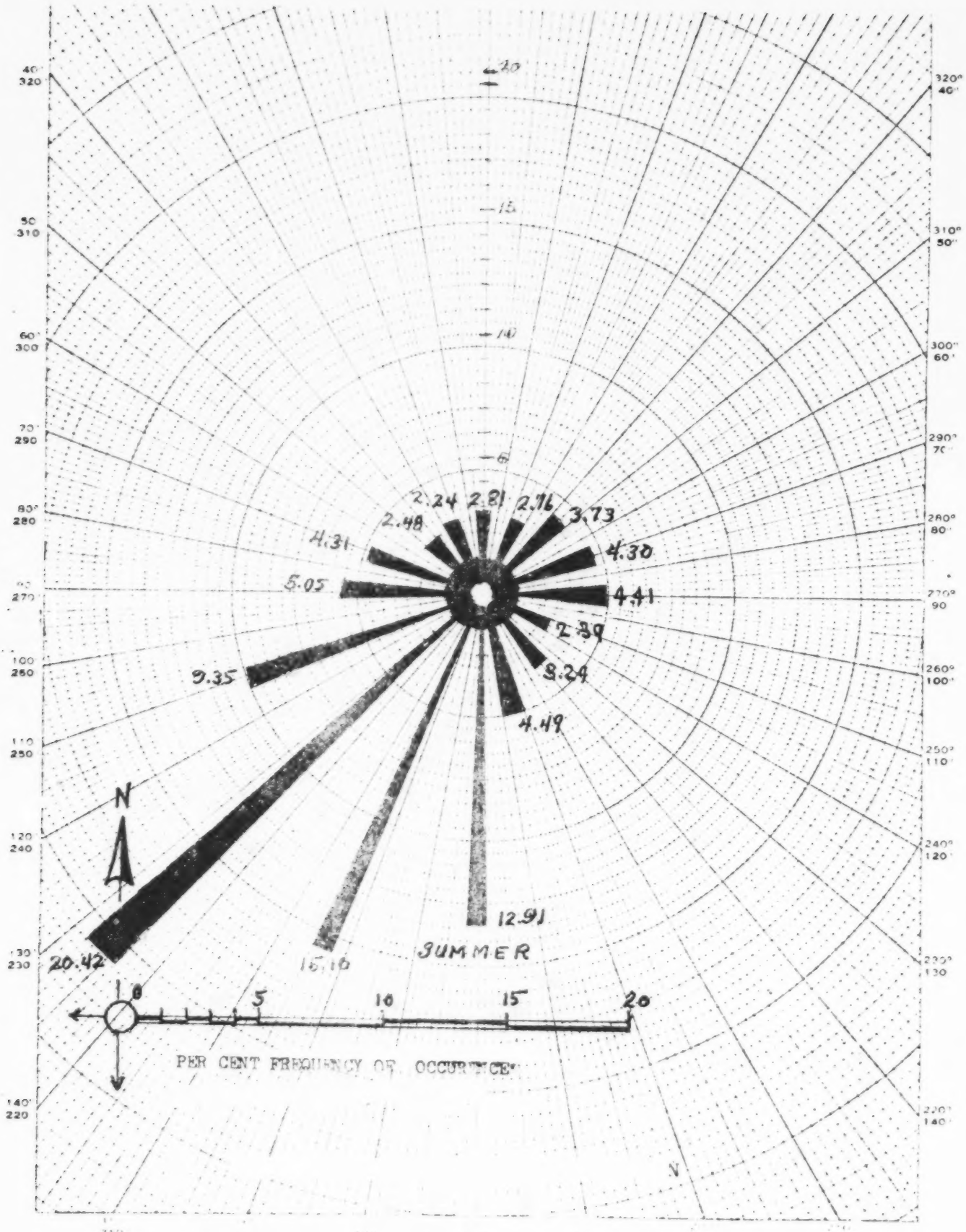


FIGURE 10. PER CENT FREQUENCY OF WIND DIRECTION, SUMMER

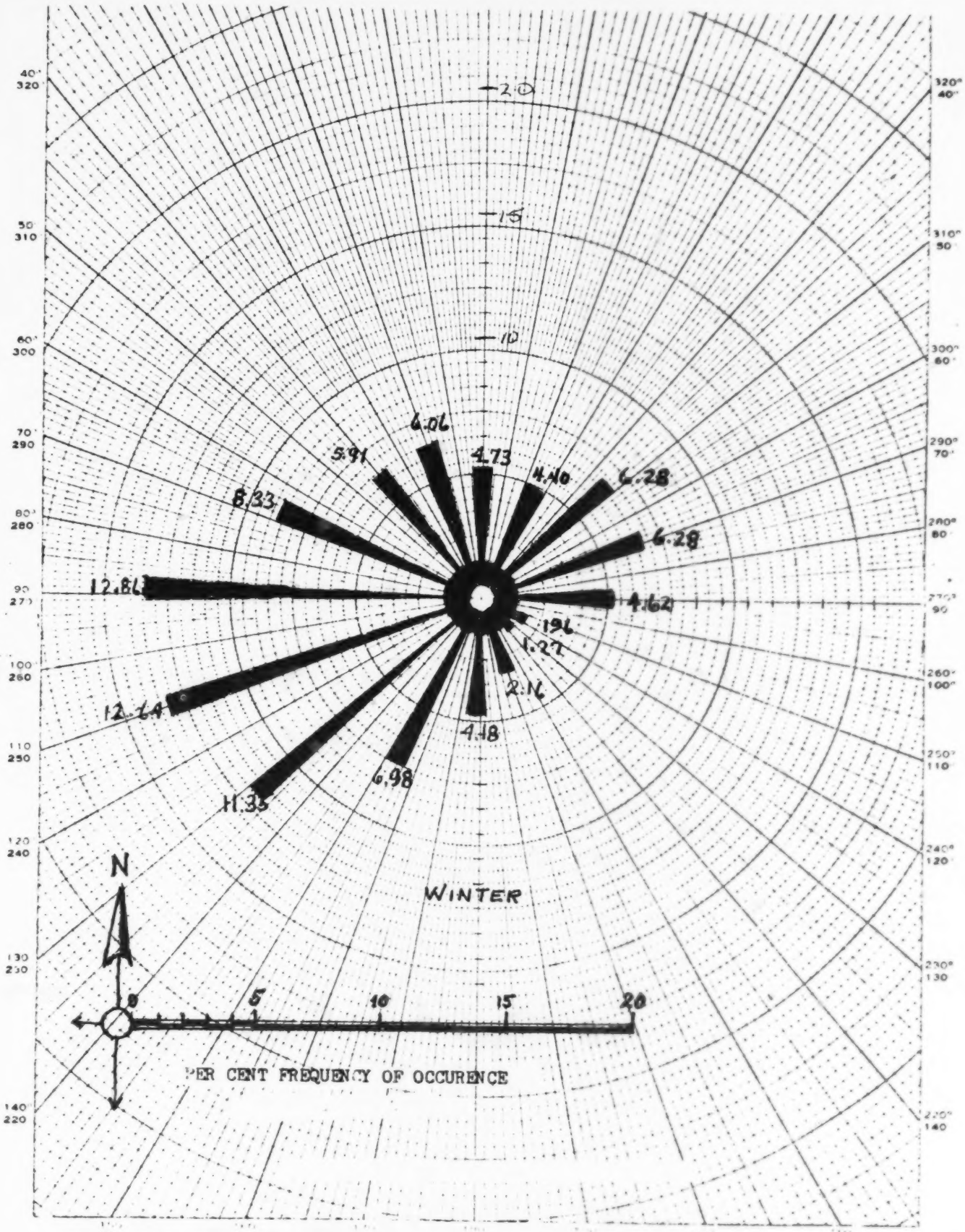


FIGURE 11. PER CENT FREQUENCY OF WIND DIRECTION, WINTER

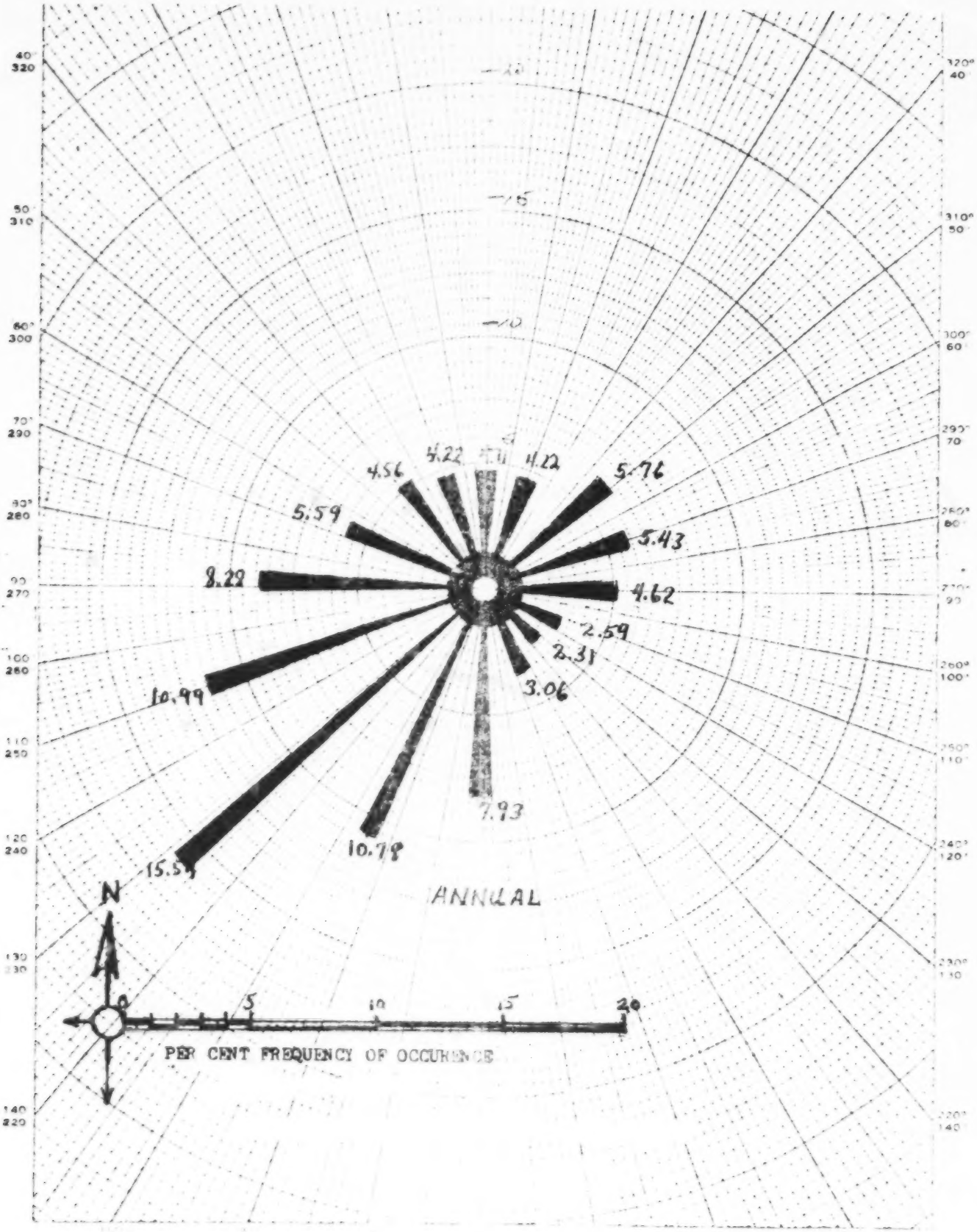


FIGURE 12. PER CENT FREQUENCY OF WIN DIRECTION, ANNUAL

large valleys similar to the Las Vegas Valley are; to the North East, Dry Lake Valley and to the South East, Eldorado Valley, the Southern half of which is known as Piaute Valley which opens into relatively flat lands and desert areas of the great Mohave desert. In general, these topographic conditions are big factors in the air pollution problem in the Las Vegas, Clark County Study Area.

AIR QUALITY ANALYSIS

The regional approach to air resource management requires that all major sources of pollution in an urban area be located within the same air quality control program. One must also consider the influence of pollution upon people and property once its emitted into the ambient air. The "core" area of a region can be roughly defined on the basis of pollutant source locations and relative emission densities. However, ambient air quality analysis is necessary in order that peripheral pollutant receptor areas may be identified and subsequently included in the quality control region. This procedure results in an essentially self-contained region, in that it will include within its bounds virtually the entire source-receptor system for a particular area. In that way too, the possibility of pollutants cross-boundary transport problems will be minimized. Two approaches have been used to provide an indication of air quality in the Las Vegas, Clark County Study Area. The first most logical approach for the determination of air quality is to measure quantitatively pollutant concentrations in ambient air. For the purposes of this report, a review of

existing air quality data was made. The second approach consists of predicting air quality over the region. This has been done by use of a meteorological diffusion model. This technique is particularly desirable in the Study Area since existing sampling networks do encompass large enough areas so that they may be used as guides to establishment of the exact outer limits of the region.[10,11] Comparisons are made between results of the air quality monitoring program and the predicted air quality results of the diffusion model. These are discussed as part of the diffusion model section of this report. The diffusion model predicts only those levels attributed to point and area sources and does not include background levels.

DIFFUSION MODEL

The diffusion model is based on the Gaussian Diffusion Equation,[1] described by Pasquill and modified for long-term averages for application to the multiple-source situation typical of an urban complex. The basic equation assumed the concentration of a pollutant within a plume has Gaussian distribution about the plume centerline in the vertical and horizonal directions. The dispersion of the plume is a function of the emission rate, effective source and receptor heights, atmospheric stability and the distance from the source. The plume is assumed to move downwind according to the mean wind.[12]

Table 18

Average Mixing Depths For

Las Vegas - Clark County Area

By Season And Time Of Day

SEASON	MIXING DEPTH, METERS		
	Average Morning	Average Afternoon	Average Morning and Avternoon
Winter (Dec., Jan., Feb.,)	254	1125	695
Summer (June, July, August)	285	3670	1980
Annual Four Seasons()	300	2410	1355

The diffus ion model was used to predict concentrations of SO_2, and total particulates. The averaging times were the summer and winter seasons,and the entire year. In order that the theoretical pollutant levels could be determined, it was necessary to evaluate certain meteorological input parameters. These parameters are wind direction and frequency of occurence in each direction, effective wind speeds for each direction, and mixing depths for various times.

The wind roses in figures 10 , 11 , and 12 show the percent frequency of wind direction for summer, winter, and annual of 1969 for Las Vegas - Clark County Area. The represent graphically the frequency of occurrence of the wind from various compass directions. This data, along with effective wind speeds for the respective compass directions, was used as input data to the computerized model. The characteristic prevailing wind directions for each of the averaging times as depicted by the length of the wind rose radials, produce a direct influence over the dispersion of pollutants.

Table 18 shows the average mixing depths for the winter, summer, and annual averaging periods. A significant diurnal variation in the mixing depth is to be noted. Mixing depths define the volume of air above the surface through which pollutants are allowed to mix, and are assumed to have no spatial variation (i.e., mixing depth is constant) over the receptor grid system.

The diffusion model was used to compute the ground level concentrations of pollutants at 225 receptor points, located at

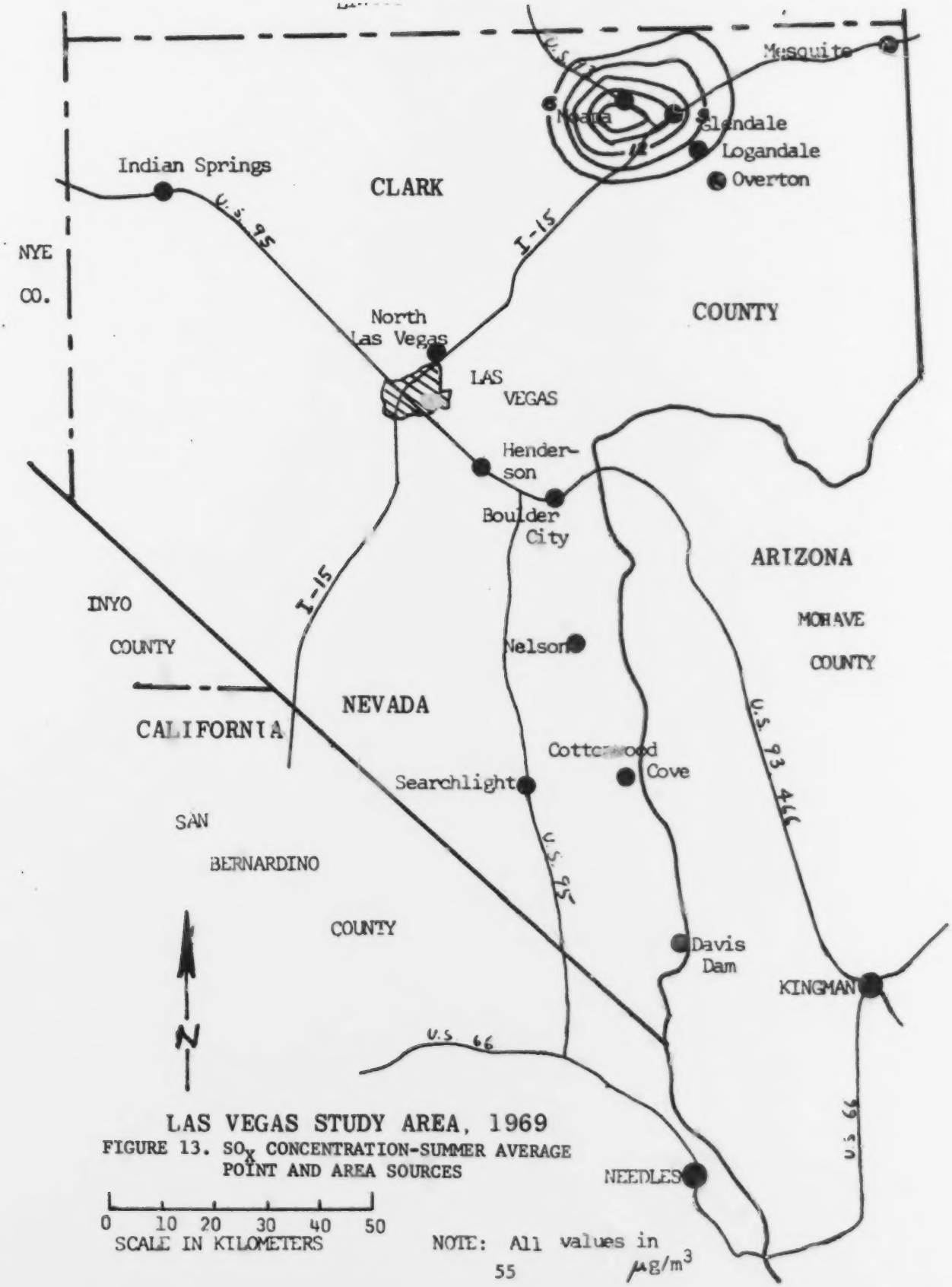
intersections of grid lines spaced 15 kilometers apart. The entire grid is centered on the city of Las Vegas and covers an area of 210 kilometers on a side.

A note of caution regarding the air pollutant concentrations resulting from the diffusion model; the concentration contours are theoretical in nature and are not intended to show absolute levels of ambient air quality. The contour lines show relative levels and should be used as a guide to examine areas affected by pollutant emissions.[13]

SULFUR OXIDES

Figure 13, 14, and 15 present the summer, winter and annual theoretical concentrations of sulfur dioxide in the Las Vegas Study Area. The three maps indicate the major source affects the townships of Moapa, Glendale, Logandale, and Overton. The source is a coal fired power plant.

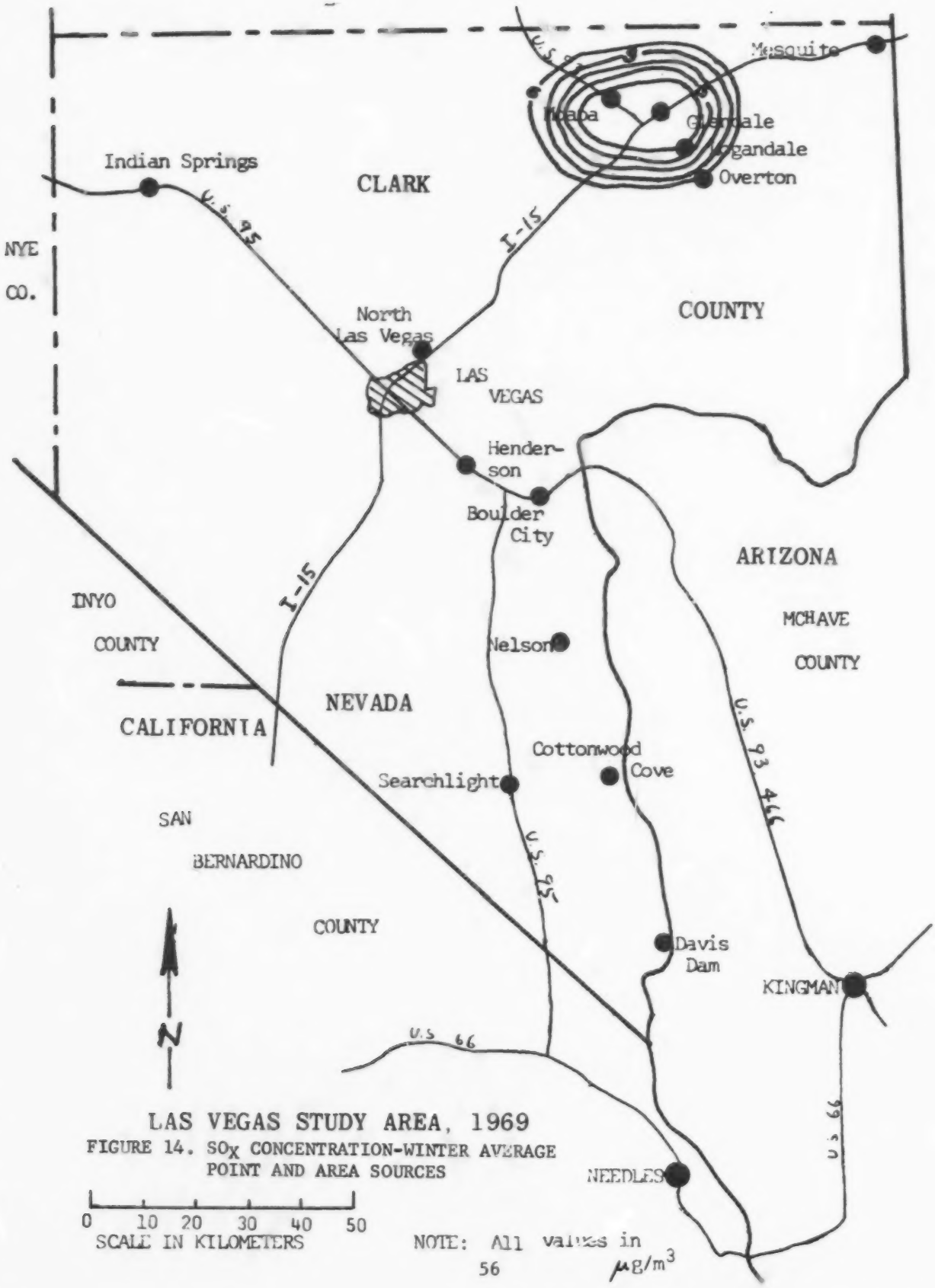
The concentration of sulfur dioxide in the vicinity averages about 18 ug/m^3 throughout the year. This concentration will spread out in the winter over the communities of Glendale and Moapa. The concentration at Logandale varies from 7 ug/m^3 in the summer to 15 ug/m^3 in the winter. The town of Overton experiences less than 6 ug/m^3 average concentration level. A small pocket of concentration develops south of Las Vegas in the winter. This is about 6 ug/m^3.



LAS VEGAS STUDY AREA, 1969

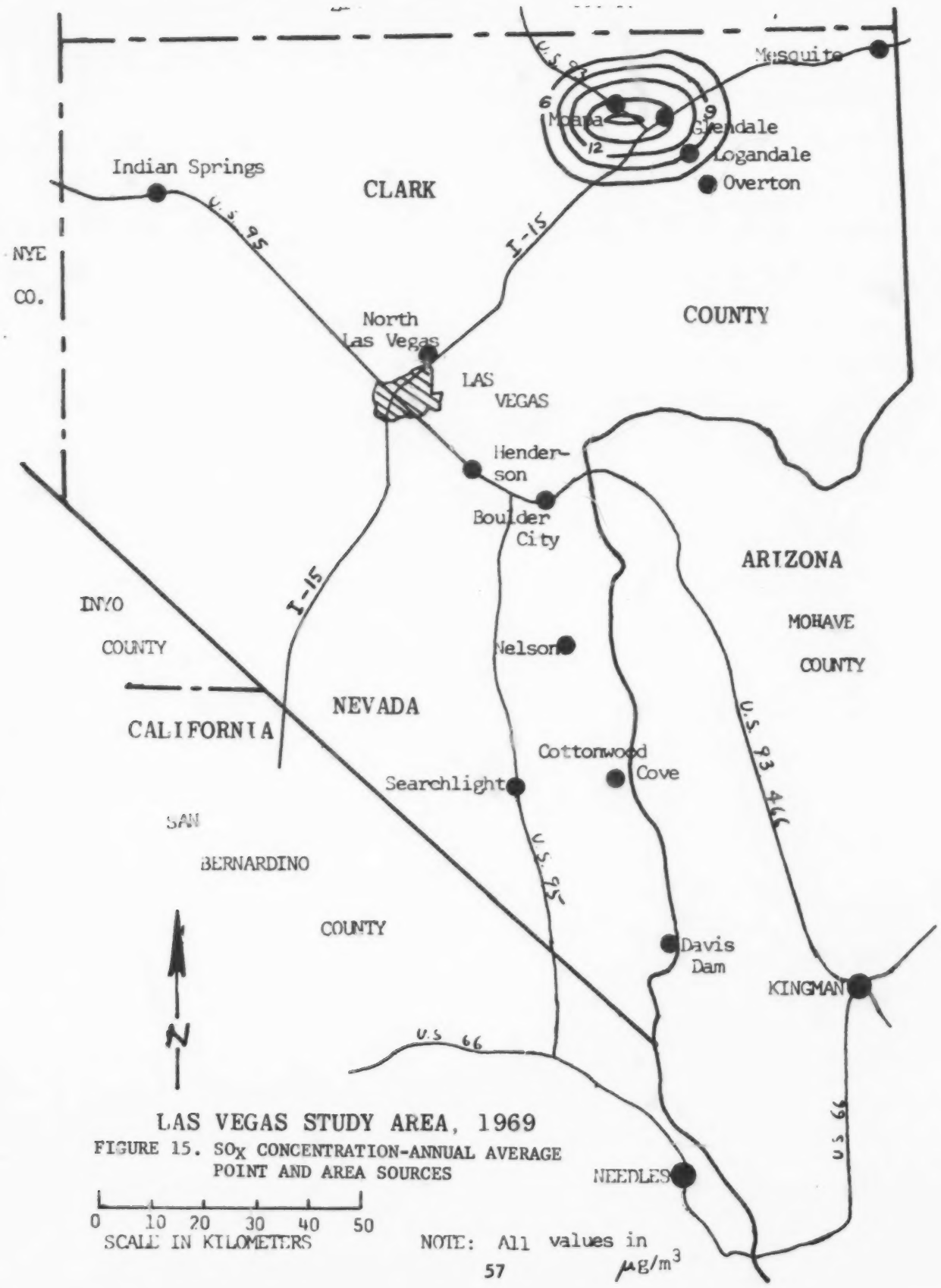
FIGURE 13. SO_X CONCENTRATION-SUMMER AVERAGE POINT AND AREA SOURCES

NOTE: All values in $\mu g/m^3$



LAS VEGAS STUDY AREA, 1969

FIGURE 14. SO_X CONCENTRATION-WINTER AVERAGE POINT AND AREA SOURCES



LAS VEGAS STUDY AREA, 1969

FIGURE 15. SO_X CONCENTRATION-ANNUAL AVERAGE POINT AND AREA SOURCES

NOTE: All values in $\mu g/m^3$

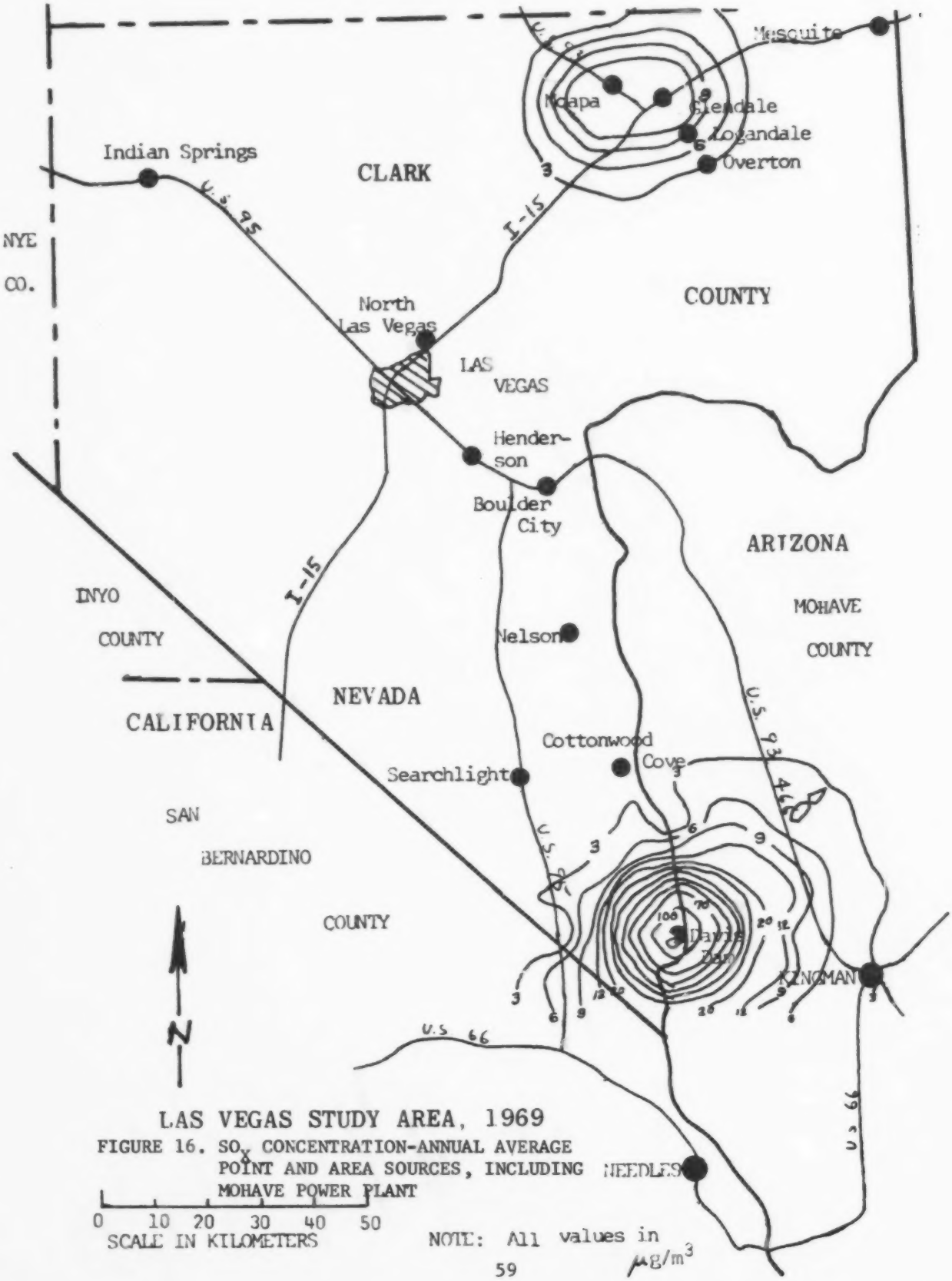
Sulfur dioxide measurements made in the past in Las Vegas have indicated very low concentrations.

Figure 16 shows the annual average sulfur dioxide concentrations to be expected from a coal fired power plant currently under construction. An average of 130 ug/m^3 is predicted in the immediate area of the power plant. The theoretical levels for most of Lake Mohave are from 100 ug/m^3 down to about 3 ug/m^3. It is notable that most of this area as well as areas along the Colorado River, that are south of this source, are recreation and residential lands.

PARTICULATES

Figures 17 , 18 , and 19 show theoretical suspended particulate concentrations as determined by the diffusion model. These concentrations represent conditions on average summer and winter days and on an annual average basis. A study of the extent of the affected area on a summer, winter, and annual basis reveals that changing meteorological conditions cause the most widespread effects. The high percentage of particulate matter produced by industrial processes has its effects on the ambient concentrations over much of the study area.

During the summer the average theoretical particulate concentration from point and area sources is over 30 ug/m^3 over Southern Las Vegas. In the winter this level spreads out over Henderson.

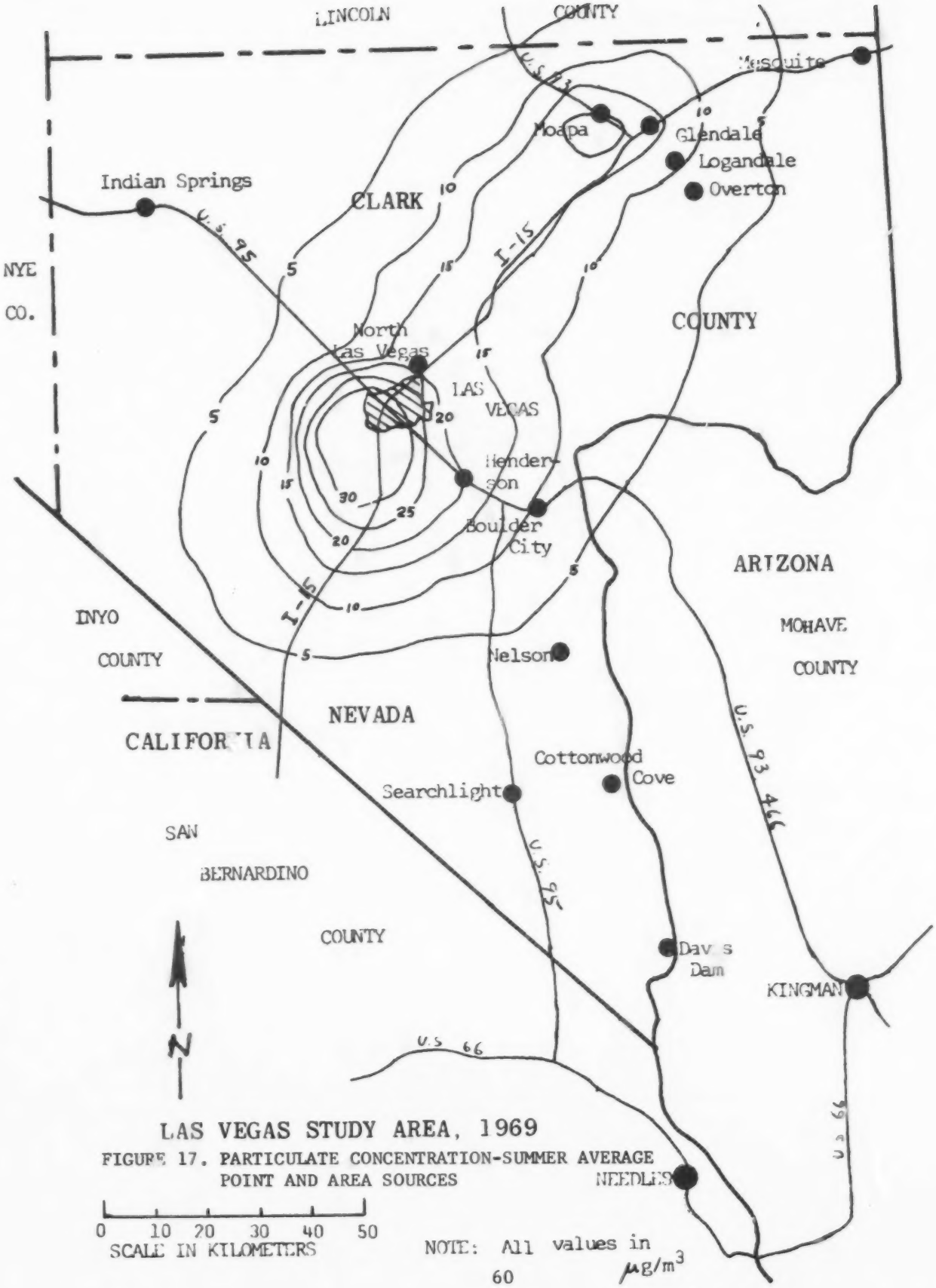


LAS VEGAS STUDY AREA, 1969

FIGURE 16. SO_x CONCENTRATION-ANNUAL AVERAGE POINT AND AREA SOURCES, INCLUDING MOHAVE POWER PLANT

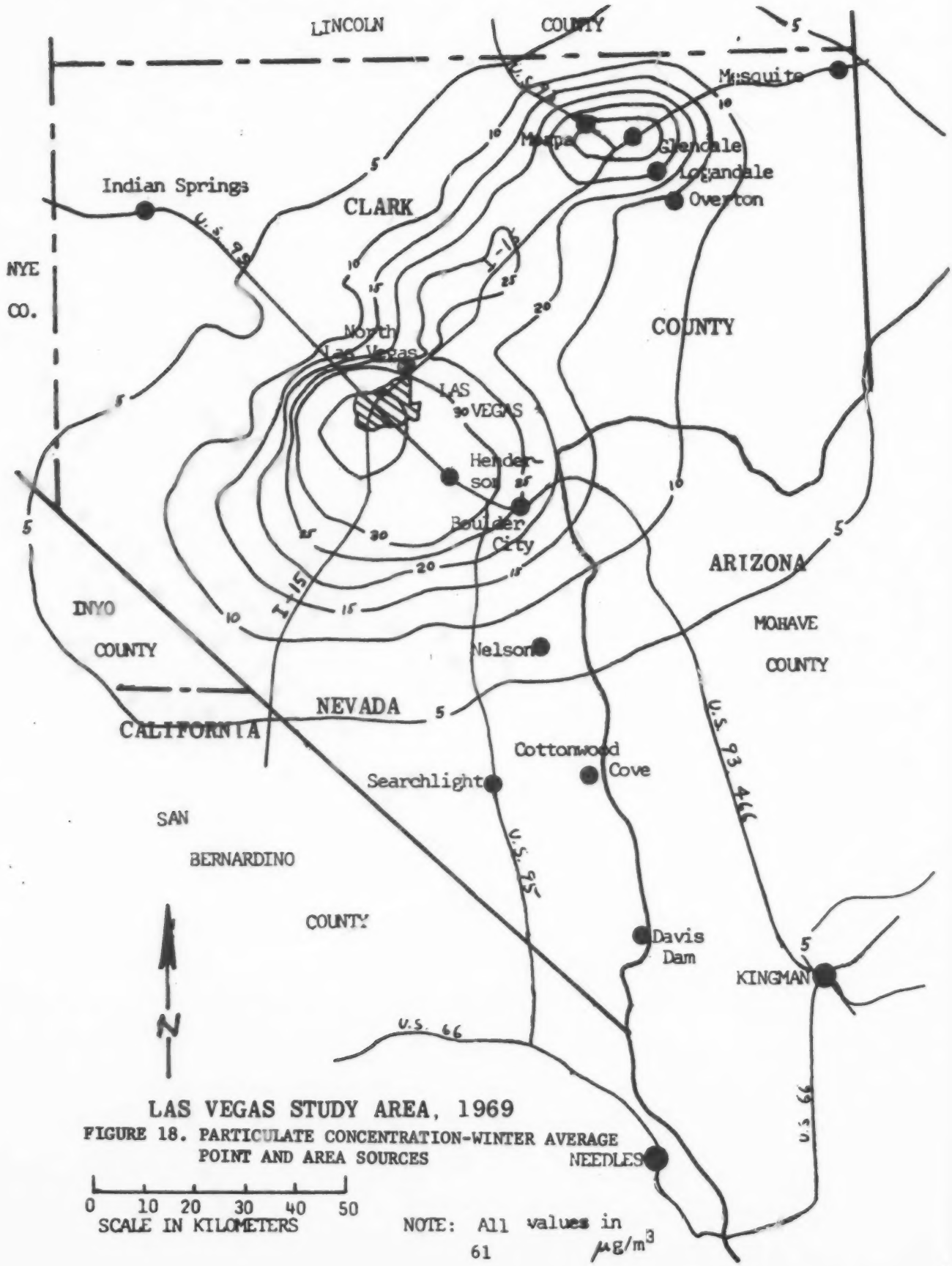
0 10 20 30 40 50
SCALE IN KILOMETERS

NOTE: All values in $\mu g/m^3$



LAS VEGAS STUDY AREA, 1969

FIGURE 17. PARTICULATE CONCENTRATION-SUMMER AVERAGE POINT AND AREA SOURCES



LAS VEGAS STUDY AREA, 1969

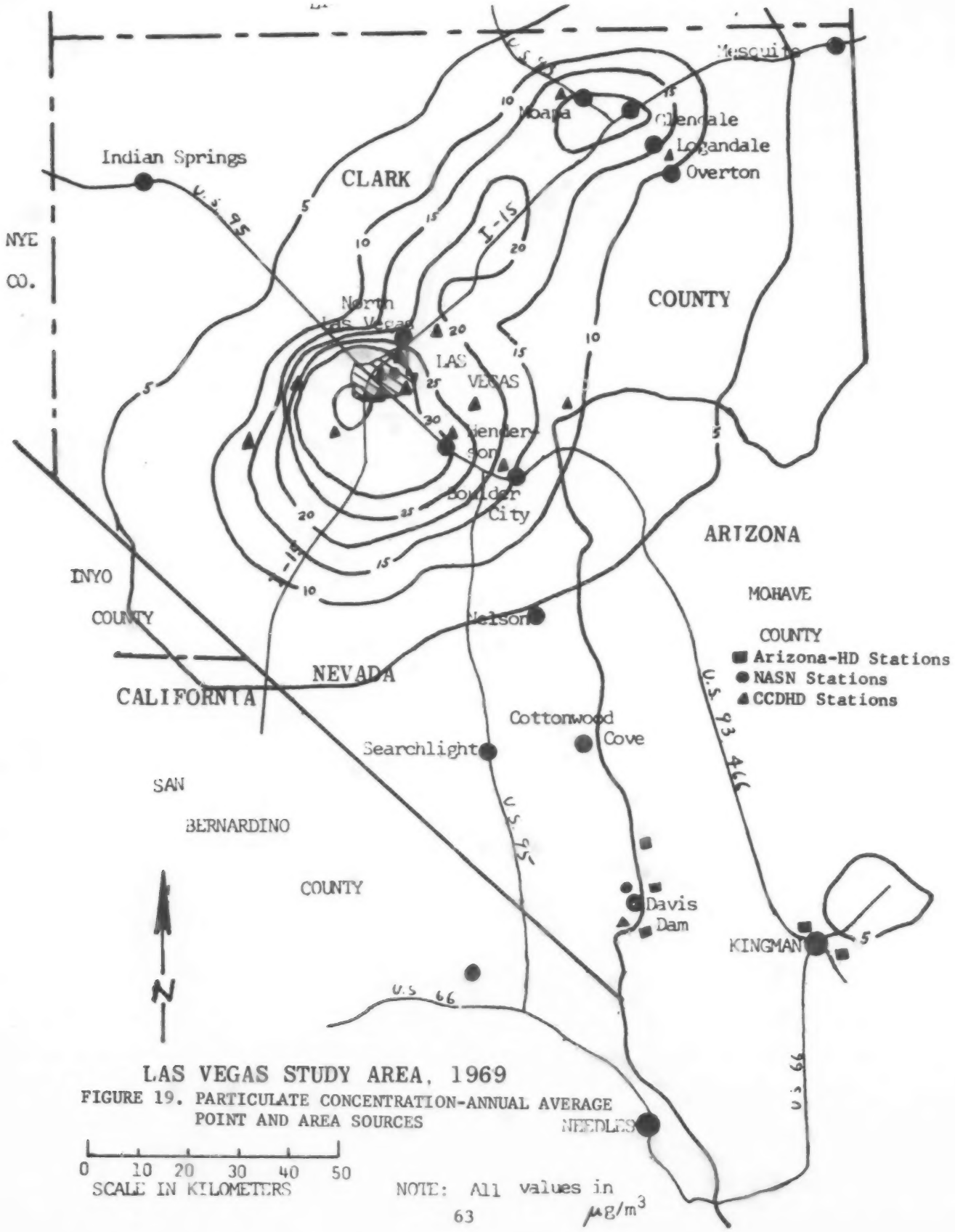
FIGURE 18. PARTICULATE CONCENTRATION-WINTER AVERAGE POINT AND AREA SOURCES

NOTE: All values in $\mu g/m^3$

The average concentration goes up to over 20 ug/m^3 around the Moapa Power Plant in the summer, and over 30 ug/m^3 in the winter. Theoretical effects from these sources extend generally along the northeastern-southwestern axis. They extend beyond Lake Mead and as far south as Nelson.

The District Health Department of Clark County Nevada has fourteen sampling stations, shown in figure 19. There are also three N.A.S.N. Stations. Routine sampling for suspended particulates and dustfall was conducted throughout the County. Highest yearly suspended particulate average concentrations occurred in North Las Vegas (10[illegible] ug/m^3), Las Vegas (230 ug/m^3) and East Las Vegas (141 ug/m^3). Another station located at South Point measured a yearly average of 47 ug/m^3. Winter average concentrations were generally greater than annual averages, while summer averages were lower. A yearly average for all 14 stations was 89 ug/m^3. The average concentrations for urban sampling sites exceeded those of non-urban sites by a significant amount. All results include background levels.[14]

The Arizona State Health Department maintains five stations for the determination of the suspended particulate concentrations at Kingman, Bullhead City, and Davis Dam. The highest yearly average was at Davis Dam (48.3 ug/m^3) and the lowest at a point three miles above the dam (12.2 ug/m^3). A yearly average concentration for all 5 stations was 22.3 ug/m^3. No data was available for the Needles, California area.



LAS VEGAS STUDY AREA, 1969

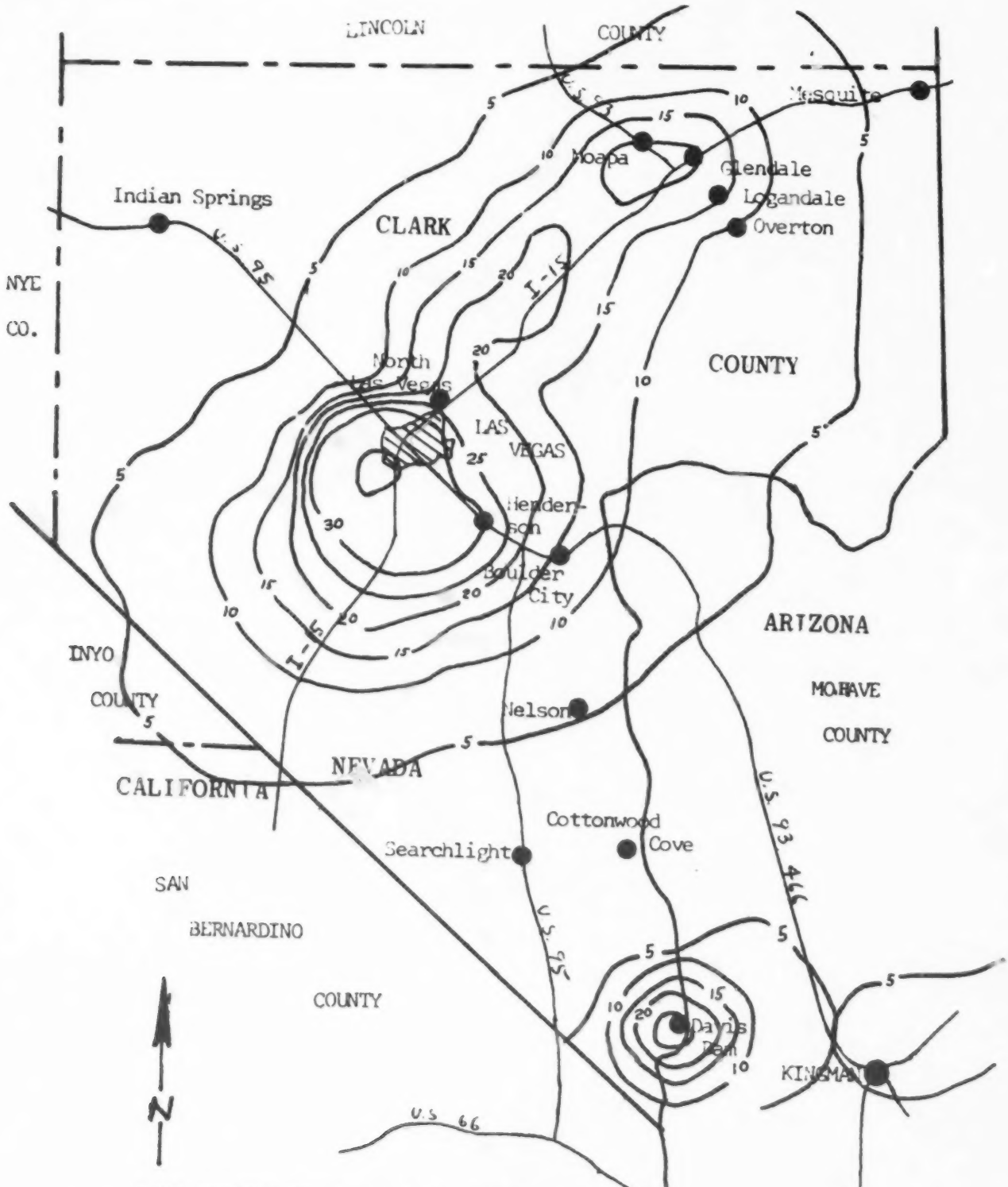
FIGURE 19. PARTICULATE CONCENTRATION-ANNUAL AVERAGE POINT AND AREA SOURCES

NOTE: All values in $\mu g/m^3$

Figure 20 shows the predicted annual average particulate concentration for the study area and includes emissions from a currently under construction coal fired steam-electric power plant at South Point, Nevada. The additional concentration is predicted as over 25 ug/m^3 near the source. This level occurs in the community of Bullhead City, Arizona, and Laughlin, Nevada. The River Bend area, south of the power plant will experience about 20 ug/m^3, as will the southern end of Lake Mohave. Measurements are presently being taken in these areas to determine existing levels of sulfur dioxide. They will continue to be made after the plant is in operation to determine the actual extent that this source contributes to the sulfur dioxide concentrations.

CARBON MONOXIDE

Figures 21, 22, 23 show the average theoretical concentrations of carbon monoxide during the summer, winter and annually. These concentrations are centered around the City of Las Vegas. Since the source of carbon monoxide is considered in area source, the concentration levels decrease uniformly as distance from the center increases. The average level in Las Vegas exceeds 150 ug/m^3 in the summer, 250 ug/m^3 in the winter, and averages about 200 ug/m^3 annually.

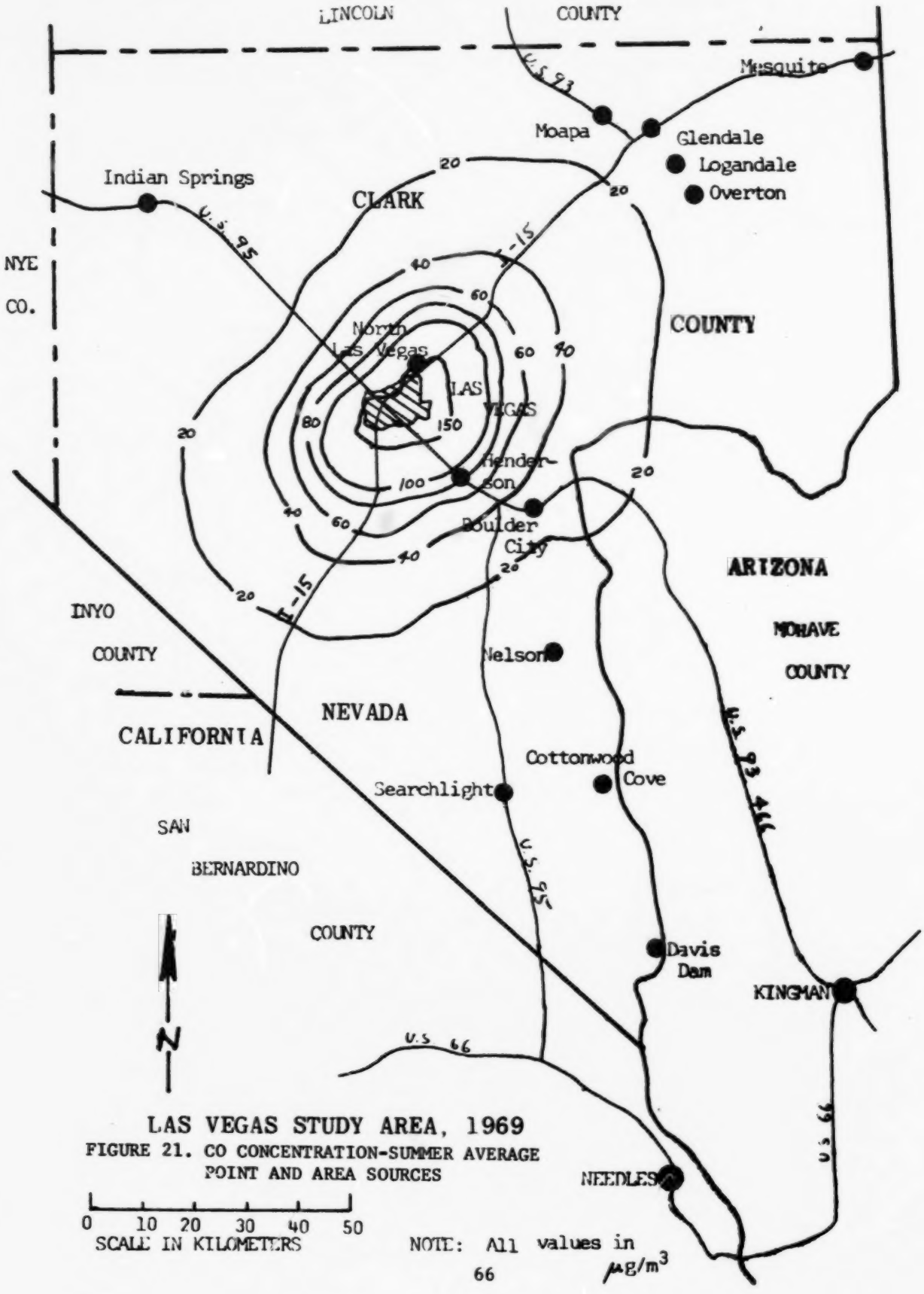


LAS VEGAS STUDY AREA, 1969

FIGURE 20. PARTICULATE CONCENTRATION-ANNUAL AVERAGE POINT & AREA SOURCES, INCLUDING MOHAVE POWER PLANT

0 10 20 30 40 50
SCALE IN KILOMETERS

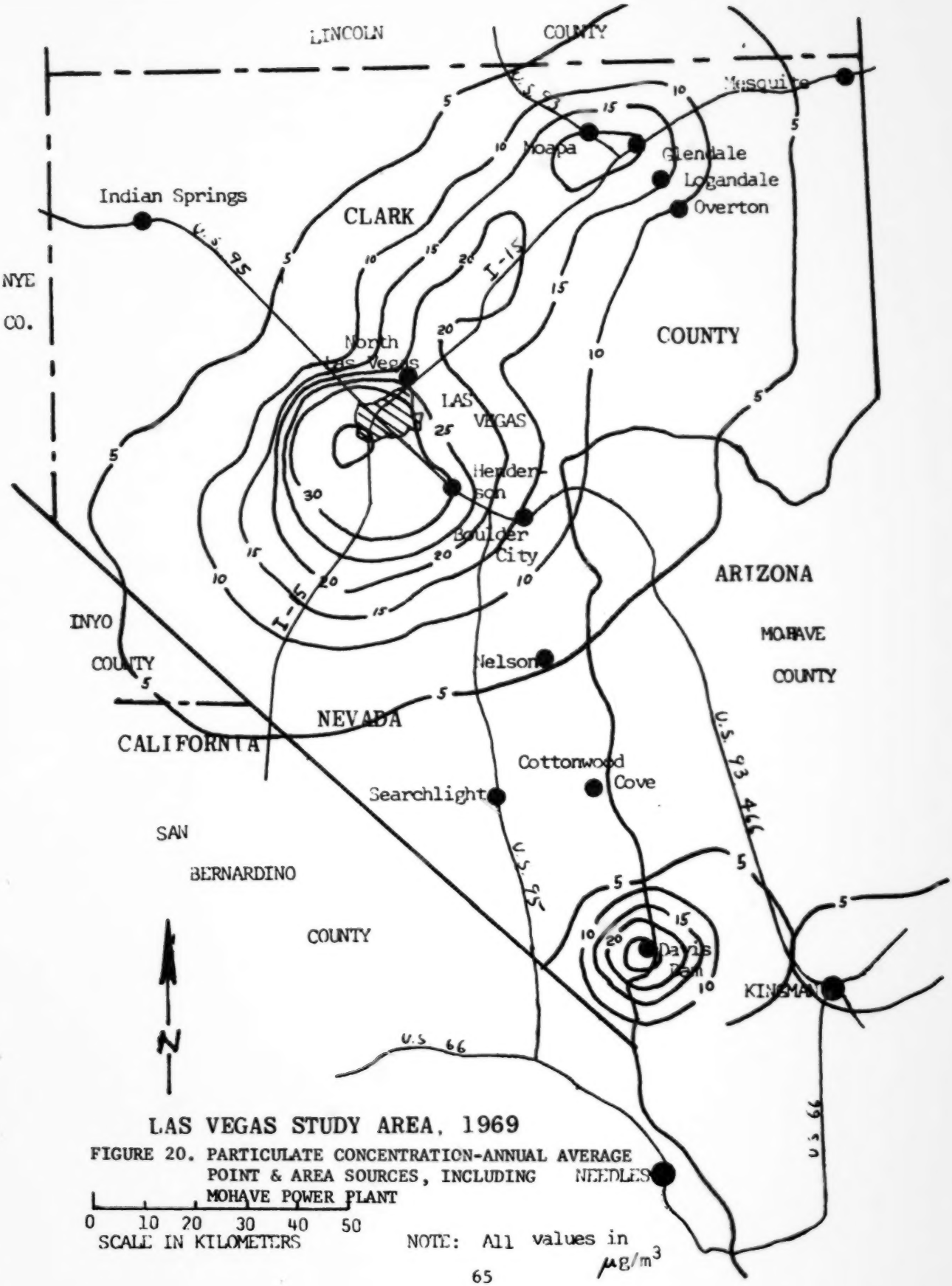
NOTE: All values in $\mu g/m^3$



LAS VEGAS STUDY AREA, 1969

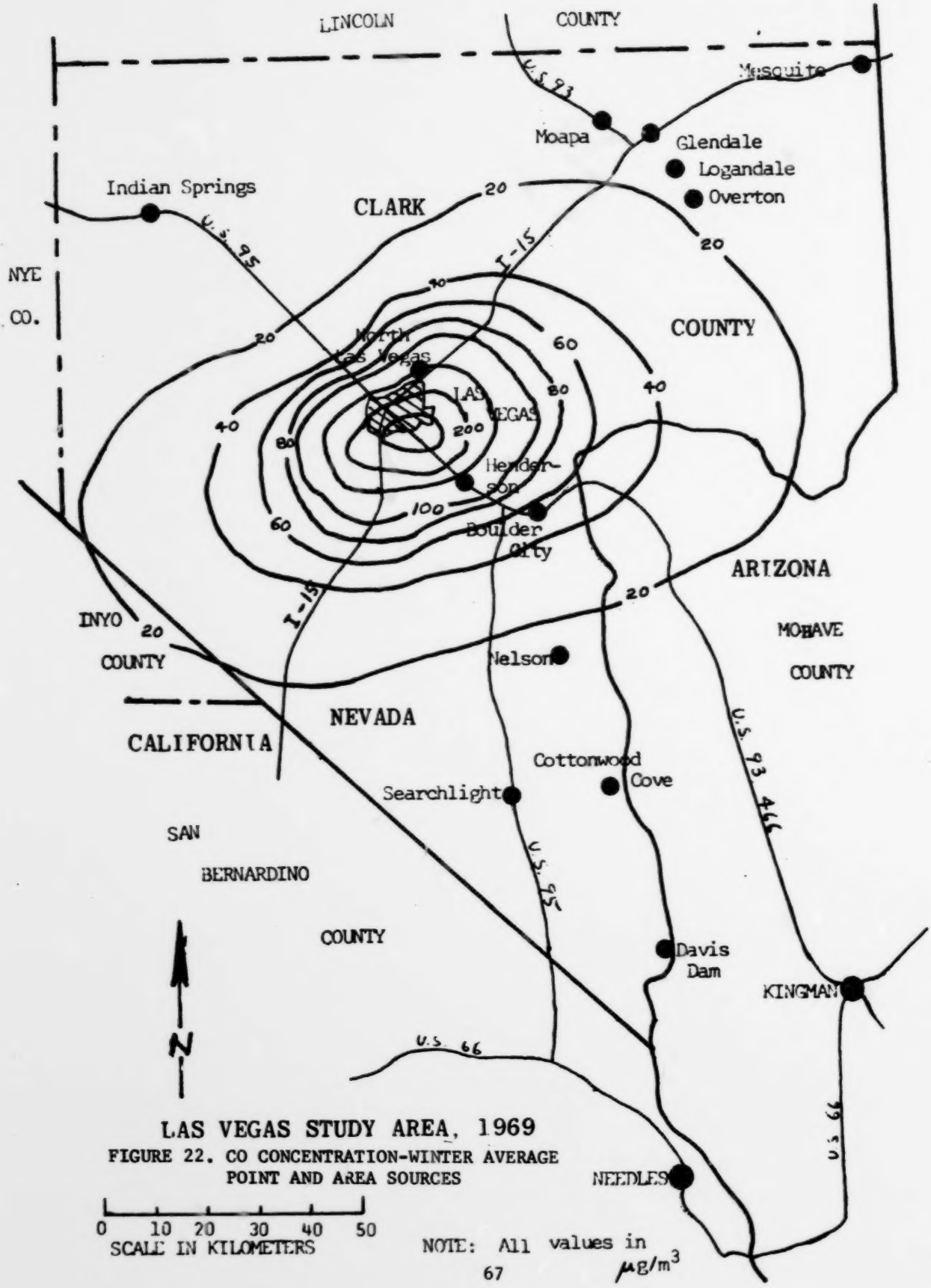
FIGURE 21. CO CONCENTRATION-SUMMER AVERAGE POINT AND AREA SOURCES

NOTE: All values in $\mu g/m^3$



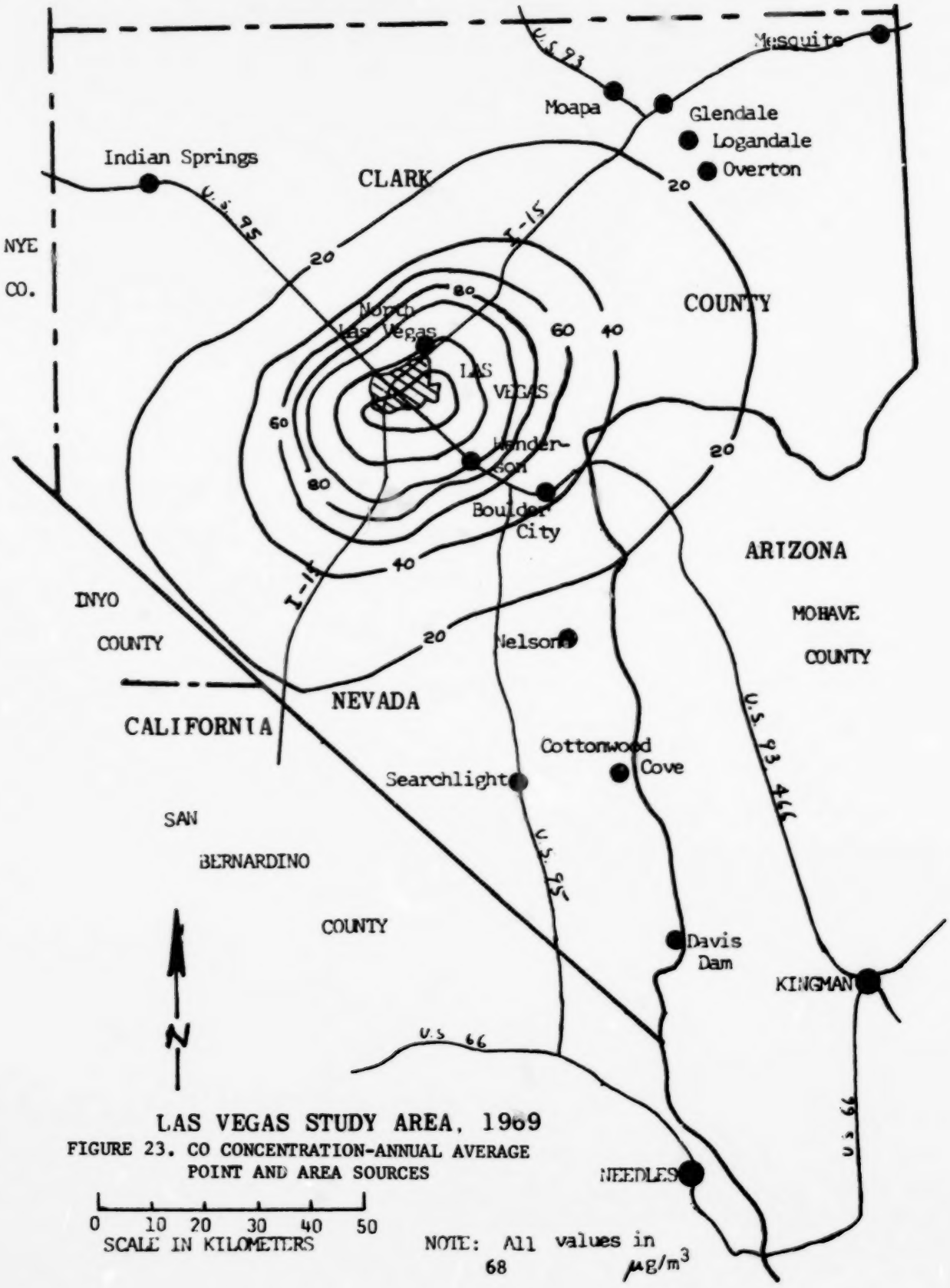
LAS VEGAS STUDY AREA, 1969

FIGURE 20. PARTICULATE CONCENTRATION-ANNUAL AVERAGE POINT & AREA SOURCES, INCLUDING MOHAVE POWER PLANT



LAS VEGAS STUDY AREA, 1969

FIGURE 22. CO CONCENTRATION-WINTER AVERAGE POINT AND AREA SOURCES



LAS VEGAS STUDY AREA, 1969

FIGURE 23. CO CONCENTRATION-ANNUAL AVERAGE POINT AND AREA SOURCES

NOTE: All values in $\mu g/m^3$

PART C

EVALUATION OF URBAN FACTORS

INTRODUCTION

The Clean Air Act, as amended, calls for a designation of air quality control regions based on "jurisdictional boundaries, urban-industrial concentrations, and other factors" in order to provide for the adequate implementation of air quality standards. The designation of air quality control regions must also be based on a consideration for existing cooperative regional arrangements, State and local air pollution control programs, and the patterns and rates of urban growth.

DESCRIPTION OF STUDY AREA

The Study Area for the regional study of the Las Vegas Metropolitan Area consists of portions of four counties--all of Clark County, Nye County as far north as Beatty, Mohave County to its southern boundary and as far west as Kingman, and a narrow strip of San Bernardino County along the Colorado River. T he four-county area is located in the southern tip of Nevada at the junction of the three states of Nevada, California, and Arizona. Figure 24 shows the location of the Las Vegas Study Area relative to other large cities in the vicinity.

Figure 25 represents a more detailed drawing of the Las Vegas Study Area showing its major cities. The Study Area occupies approximately 19,000 square

miles and contained an estimated 1969 population of 365,000. It should be noted that this does not include the great influx of tourists into Las Vegas which is estimated to add about 70,000 people on any given day.[15] The population density map (Figure 26) shows the heaviest concentrations near Las Vegas. Table 19 shows the population and area of the various counties within the Study Area.

TABLE 19 AREA AND POPULATION CHARACTERISTICS FOR THE LAS VEGAS STUDY AREA

County	Land Area (Sq. Mi.)	Population 1960	Population 1969	Population Density (1969)
Clark	7,874	127,000	344,000[b]	44
Mohave[a]	4,500	c	17,100	4
Nye[a]	3,000	c	2,400	0.8
San Bernadino[a]	4,000	c	1,500	0.4
TOTAL	19,374	c	365,000	16

a - Includes only a portion of the entire county.

b - Does not include an average daily level of approximately 70,000 tourist

c - Estimate not available for 1960

FIGURE 24. MAP OF LAS VEGAS STUDY AREA AND SURROUNDING STATES

FIGURE 25. MAP OF LAS VEGAS STUDY AREA SHOWING PRINCIPAL CITIES AND TOWNS

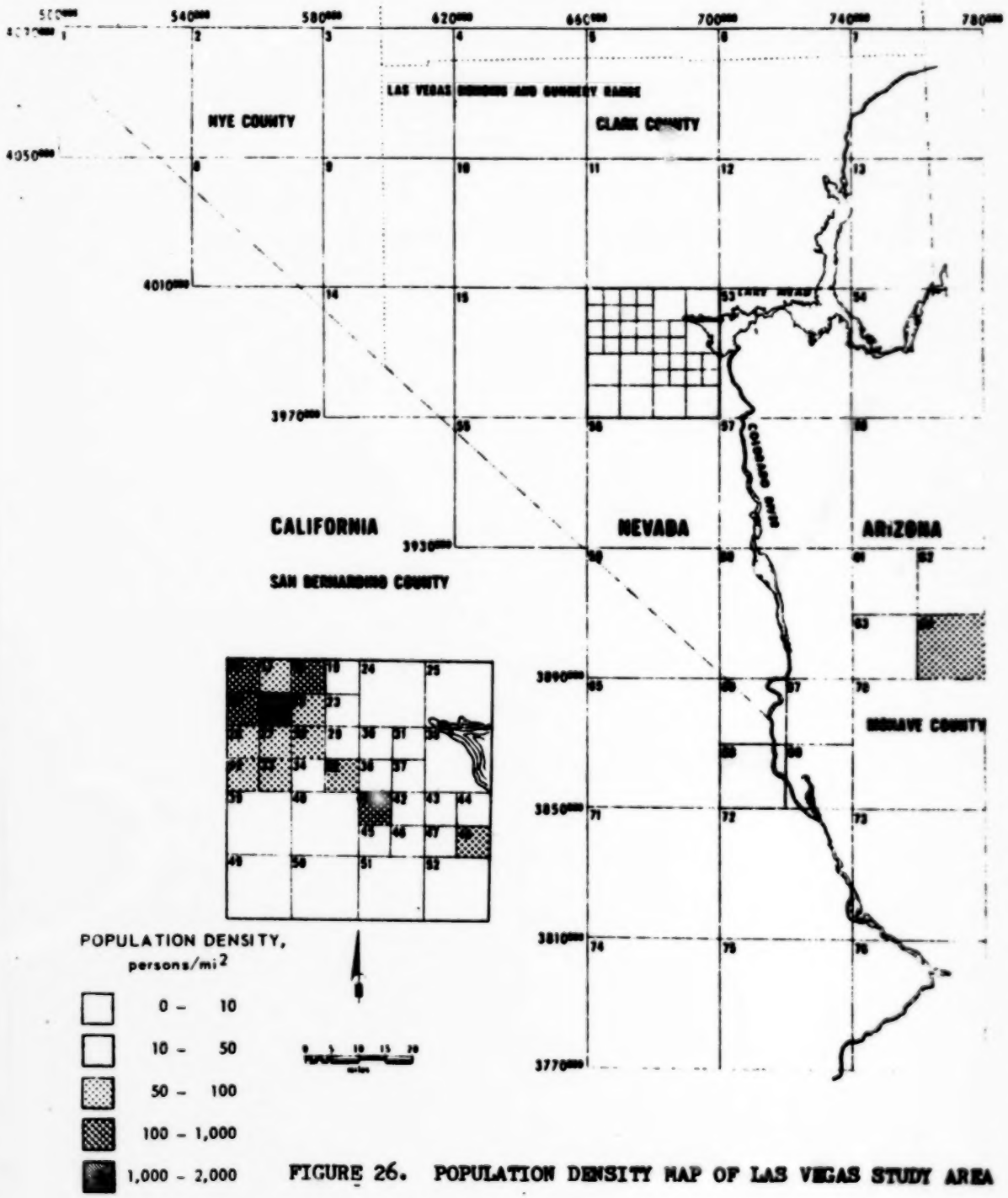


FIGURE 26. POPULATION DENSITY MAP OF LAS VEGAS STUDY AREA

POPULATION DISTRIBUTION

Existing and potential air pollution problems can be related geographically to areas subject to present or anticipated residential and industrial development. Similarly, air pollution problem areas can generally be identified by studying population statistics since human activity is the basic cause of air pollution. Table 20 shows 1969 population distribution by planning regions in Clark County, Nevada. The population density values are in persons per square mile, but does not include an average daily tourist population of approximately 70,000. In Clark County, the existing population is generally concentrated in the Las Vegas Valley. The Las Vegas Valley Planning Area encompasses 441 square miles. This includes the corporate cities of Las Vegas, North Las Vegas, Henderson and the surrounding unincorporated county area. There are presently 126 square miles within the corporate limits of the three cities. The remaining 315 square miles, 71.4 percent of the Valley, is unincorporated.

Table 21 shows projected population densities (persons per square mile) to the year 1980. Population statistics of the Clark County Planning Commission, shown in Tables 20 and 21, indicate an increase from 320,170 persons in 1969 to approximately 1,200,000 by 1980.[16] Greatest absolute growth is expected to occur in the Las Vegas Metropolitan and Valley area. It is anticipated that this growth will occur in the south, western, and northern sectors of the Valley.[17]

TABLE 20

LAS VEGAS, CLARK COUNTY NEVADA
POPULATION DISTRIBUTION, 1969

	Square Miles	Population	People Per Mile^2	% of Population
Clark County	7,927	321,720	40.5	100.00
Principal Cities				
Las Vegas	50.4	165,000	3,274.0	51.29
North Las Vegas	48.9	43,831	896.0	13.62
Henderson	26.7	16,000	599.0	4.97
Boulder City	13.5	7,200	533.0	2.24
"The Strip"	32.6	51,831	1,590.0	16.11
Unincorporated Areas (Las Vegas Valley)	282.4	30,408	108.0	9.45
Glendale Logandale Moapa Overton	625	2,600	4.2	.81
Mesquite Bunkerville	192	1,102	6.0	.35
Laughlin River-Bend South Point	95	850	9.3	.27
Indian Springs	36	1,000	28.2	.29
Searchlight Piute- El Dorado Valley	1,780	980	.6	.31
Blue Diamond	12.6	358	28.4	.12
Sloan	83	200	2.4	.06
Jean Goodsprings	77	240	3.1	.07
Charleston- Alpine Village	31	120	3.8	.04

TABLE 21

LAS VEGAS, CLARK COUNTY NEVADA POPULATION DISTRIBUTION ESTIMATES PROJECTED TO 1980 (USING 1969 CITY LIMIT BOUNDRIES)

	Square Miles	Population	People Per Mile^2	% of Population
Clark County	7,927	1,200,000	151.4	100.0
Principal Cities				
Las Vegas	50.4	650,000	12,897.0	54.16
North Las Vegas	48.9	91,000	1,861.0	7.58
Henderson	26.7	55,000	2,060.0	4.58
Boulder City	13.5	28,000	2,090.0	2.33
"The Strip"	32.6	180,500	5,537.0	15.04
Unincorporated Areas (Las Vegas Valley)	282.4	105,300	373.0	8.77
Glendale Logandale Moapa Overton	625	14,700	23.5	1.23
Mesquite Bunkerville	192	5,000	26.0	.42
Laughlin River-Bend South Point	95	50,000	526.3	4.17
Indian Springs	36	6,000	166.7	.50
Searchlight Piute- El Dorado Valley	1,780	8,000	4.5	.67
Blue Diamond	12.6	2,500	198.4	.21
Sloan	83	1,400	16.8	.12
Jean Goodsprings	77	1,300	16.9	.11
Charleston Alpine Village	31	1,300	41.9	.11

Approximately 44,100 visitors come into the Study area daily. By 1980 this figure should reach about 97,000 visitors per day. This increase will be felt chiefly in Las Vegas and in surrounding park and recreation areas.

The southeastern regions of the county, including Boulder City, should experience steady growth reaching an estimated 28,000 persons by 1980. The Laughlin - South Point region, now sparsely populated, anticipates a population increase from 880 to 50,000 persons in 1980. The Clark County Planning Commission approved the development of a 9,000 acre tract of land for a new city in this area.

The northeast regions of the county expect a normal population growth. Urban growth of the Townships of Logandale, Moapa, and Overton, 60 miles from Las Vegas Valley, with a 1969 population of 2,600 persons, will have an estimated 14,700 persons by 1980. The rate at which this growth will take place depends on a number of conditions, including adequacy of water supply and expansion of tourist attractions at nearby Lake Mead and the Valley of Fire.[18] In the Moapa Valley, development and growth is likely to consist of low density agricultural residential units. The extreme northeasterly portion of Clark County is productive as an agricultural area situated along the Virgin River. The Townships of Mesquite and Bunkerville have a combined 1969 population of 1,100 and will have an estimated population of 5,000 in 1980.[19] In terms of absolute growth, the northeastern portion of the County is not likely to experience significant growth due to the lack of water and geographical factors.

The northwestern region of the County includes the Township of Indian Springs, forty-two miles from Las Vegas on U. S. Highway 95. The population in 1969 was 1,102, and by 1980 the estimated population will be 6,000. Growth in the Indian Springs area is economically dependent upon activities of the Atomic Energy Commission at Mercury and the Military Air Base at Indian Springs.

INDUSTRY

Residents of Clark County recognize that they must preserve and protect the whole region from any industries that would in any way adversely affect this resort environment. This attitude is reflected in the policies of the Clark County Planning Commission's strict regulation of land use categories.

Clark County and the Las Vegas region is one of the least industrialized areas in the United States, and ranks first in the ratio of service employees to agricultural and manufacturing employees. Employment for services of hotel-motel casino operations is greatest, followed by: the manufacture of chemicals, and electronics, and Federal Employees at Nellis Air Force Base and A.E.C. Nevada Test Site operations. Employment is concentrated in the cities of Las Vegas, North Las Vegas and Henderson.

TOURISM

Tourism is the predominant source of income for the Las Vegas Metropolitan area. There are sixteen major resort hotels and casinos on the "Strip," employing forty-six percent of the total labor force in Clark County. The casino and hotel services accommodated 15,500,000 tourists in 1969. The resort development along the "Strip" is the largest economic asset in the Las Vegas Valley.

Continued growth of the tourist industry is dependent not only on resort development but also upon diversification of other resources including the Lake Mead National Recreational Area, the Valley of Fire and Red Rock Recreational Lands.

HEAVY INDUSTRY

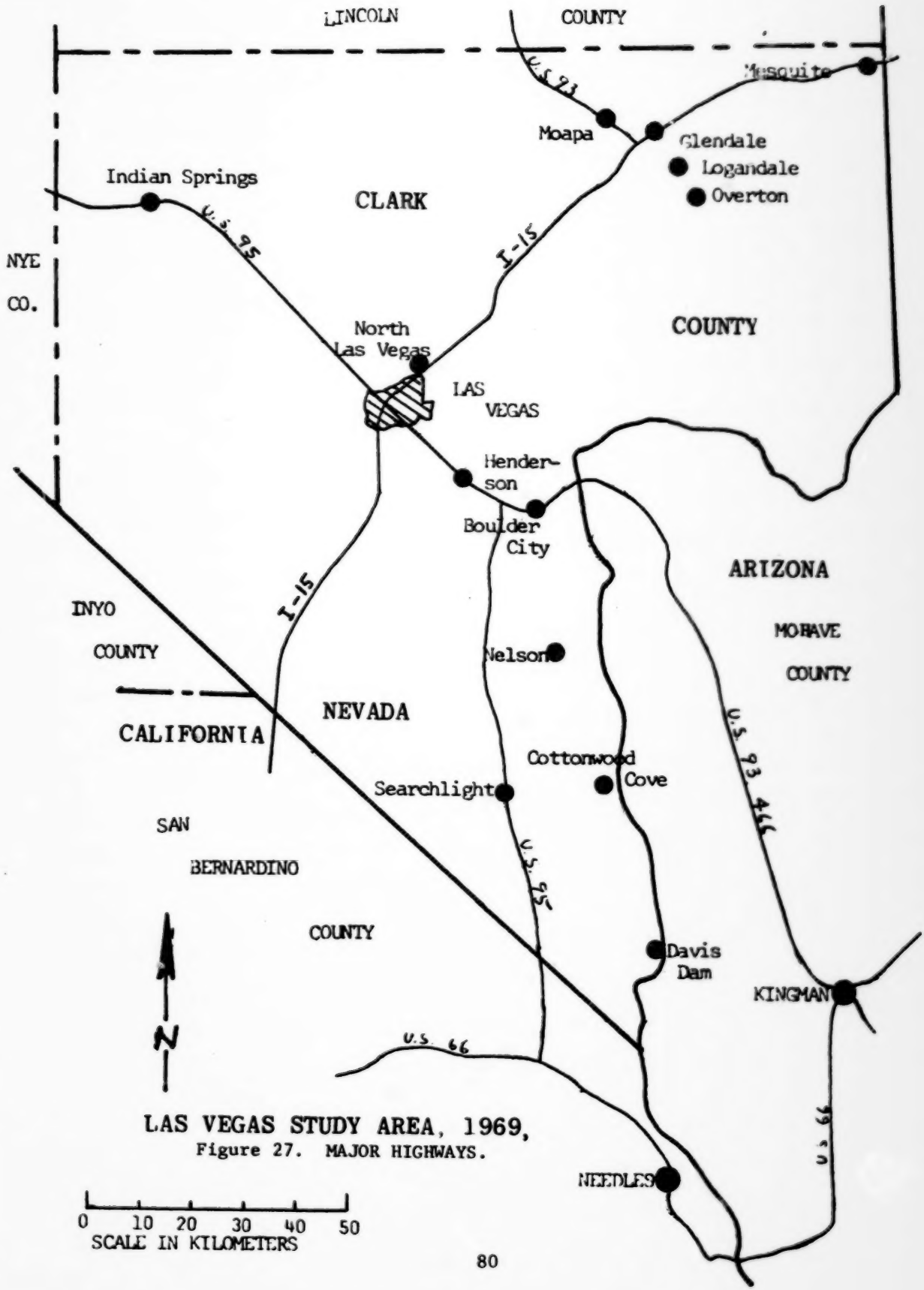
The largest single industrial complex in the area is located adjacent to the City of Henderson in the southeastern region of the Valley. This complex, Basic Management Incorporated (B.M.I.), is comprised of a number of companies engaged in reduction and refinement of raw ores and chemical production. These industries have grown steadily since World War II and now have annual payrolls exceeding $15,500,000.00.

INDUSTRIAL POTENTIAL

Excluding the hotel-motel land development, the industrial areas of the Las Vegas V alley are located mainly in incorporated areas and account for only 2,082 acres. The combined cities of Las Vegas, North Las Vegas, and Henderson contain a greater amount of industrially zoned, but presently vacant land, than any other portion of the county.

TRANSPORTATION

Figure 27, shows the major highways throughout the Las Vegas Study Area. These highways carry about 15 million visitors annually throughout the area. On a southwest-northeast axis between Los Angeles and Salt Lake City is Nevada Interstate 15 or U. S.



LAS VEGAS STUDY AREA, 1969,
Figure 27. MAJOR HIGHWAYS.

Highway 91-93. Highway 93-95-466 from Phoenix and Needles enters Las Vegas from the southeast, while U. S. Highway 95 enters from the northwest. The heaviest volume of traffic flows along interstate 15 toward and from Los Angeles. The other major arteries carry some tourist traffic and considerable domestic traffic.

Because of the large numbers of visitors that come into the Study Area, Las Vegas has become a major air transportation center. Fourteen airlines serve the area at McCarran International Airport. In addition, Nellis Air Force Base, in the northeast corner of Las Vegas Valley is active in handling military air traffic. Figure 28 shows the location of these two air fields, and in addition, shows the North Las Vegas Air Terminal which handles much of the general aviation traffic.

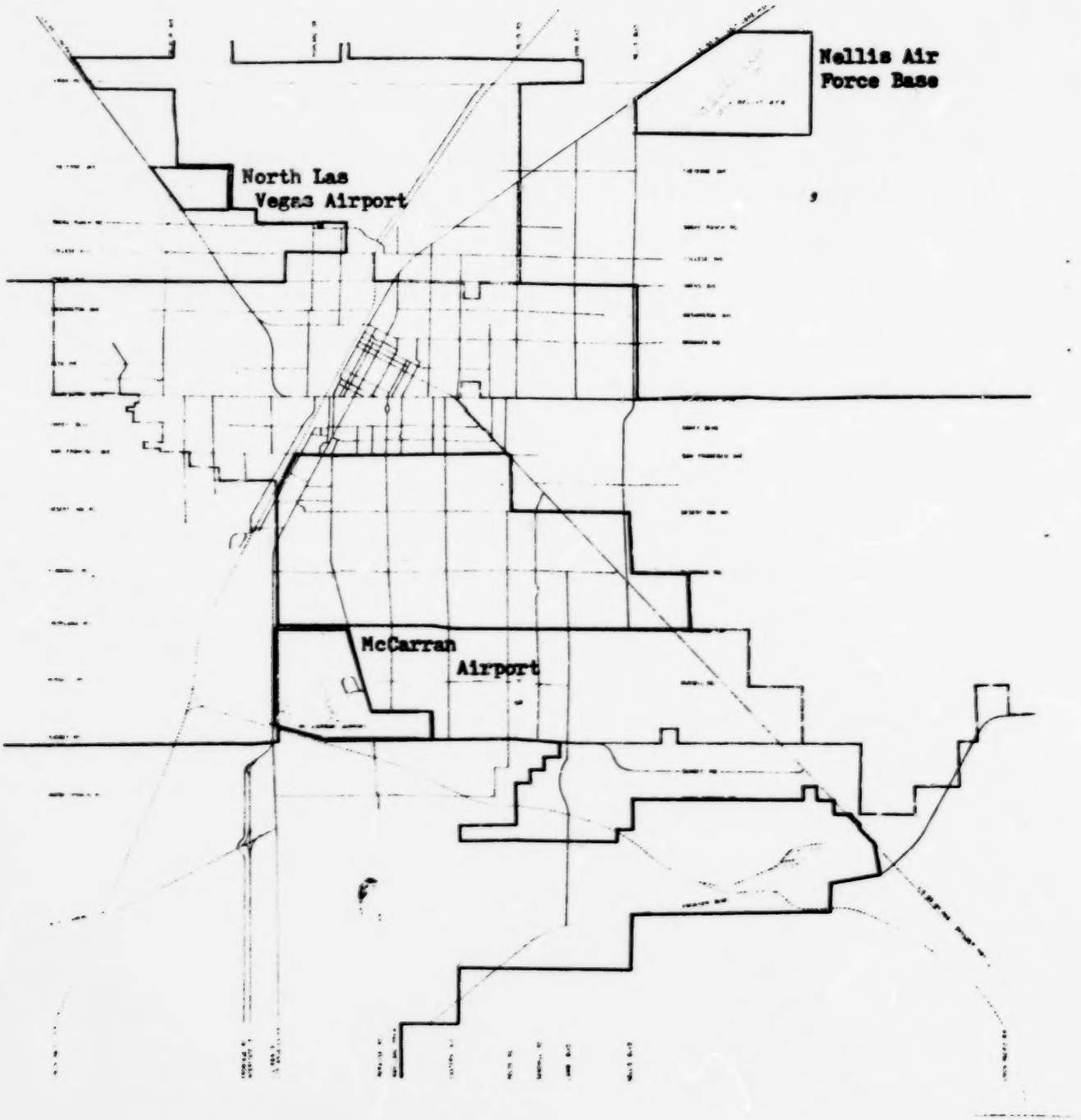


FIGURE 28. LOCATION OF AIRPORTS IN THE LAS VEGAS VALLEY.

EXISTING AIR POLLUTION CONTROL PROGRAMS AND LEGISLATION

Under Nevada's existing law, local governing bodies may form air pollution control programs. Early in 1965, the Cities and the County expressed the desire to form a single agency to provide uniform services to the entire county.

In November 1965, the Board of County Commissioners transferred the Clark County Air Pollution Control Division to the District Health Department. The Division was to function under the District Board of Health and in section 5 of the resolution 253 that board was given the authority "to enact, and enforce any and all rules and regulations in effect or hereafter deemed necessary or desirable for implementation of the several ordinances and amendments for the regulation and control of Air Pollution throughout the County."[20]

Part of the process of consolidating the air pollution control effort was to enact uniform rules and regulations throughout the District. The Air Pollution Control Regulations were adopted by the Board of Health in October of 1967, providing the legal basis for developing an enforcement program. Also in October of 1967, a Federal Grant for $50,000.00 supplemented $65,000.00 of County Funds to provide for a total operating budget of $115,000.00.

During the first two years of the program, the Air Pollution Control Division acquired basic facilities, equipment and personnel.

Enforcement procedures and monitoring techniques were developed and, more importantly, the entire community became conscious of Air Pollution problems and of the need for effective control.

In late 1969 and early 1970, the Division was enlarged. Additional Federal and County Funds were obtained and stronger control regulations were adopted to provide for strict emission control of all stationary sources.

Present funding is about $190,000.00 annually, split almost equally between County and Federal sources. The staff consists of 5 field inspectors, a Director and technical support personnel. This program is the largest and most active Air Pollution Control Program in the Study area. All other jurisdictions outside Clark County are administered through respective State Programs.

OTHER REGIONAL POSSIBILITIES

Since the Las Vegas Study Area involves more than one political jurisdiction, it is important to consider what can be done to affect a course of action that is consistant in all the involved jurisdictions. N.R.S. 277.080 to 277.180 known as the Interlocal Cooperation Act, permits public agencies "to make the most efficient use of their powers by enabling them to cooperate with other local governments on a basis of mutual advantage and thereby to provide services and facilities in a manner and persuant to forms of governmental organization which will best accord with geographic, economic, population and other factors influencing the needs and development of local communities."

Therefore, the legal mechanism exists for interjurisdictional arrangements, to the extent that the laws of such other jurisdiction permit such joint exercises.

RECOMMENDATION BY THE STATE OF NEVADA FOR THE NEVADA PORTION OF THE LAS VEGAS INTERSTATE AIR QUALITY CONTROL REGION

The State of Nevada, Bureau of Environmental Health, and the Clark County District Health Department, have reviewed the various factors presented in this report and conclude that the Nevada portion of the proposed Las Vegas Interstate Air Quality Control Region consist of Clark County. The region meets the first criteria, that of being self-contained with respect to air pollution sources and receptors, in that the population centers are located far from the county borders with adjacent Nevadan counties and the major point sources are either in the center of Clark County or near the Arizona border. The second consideration, that of future growth patterns being accounted for by the boundary selection, is also met in that the projected 1980 growth is concentrated in the central and southern portions of Clark County. Finally, the third objective of compatibility with governmental jurisdictions is satisfied by the coterminous boundaries with the only local agency responsible for air pollution control in southern Nevada, the Clark County District Health Department.

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